SCIENTIFIC AMERICAN SUPPLEMENT. No. 1148

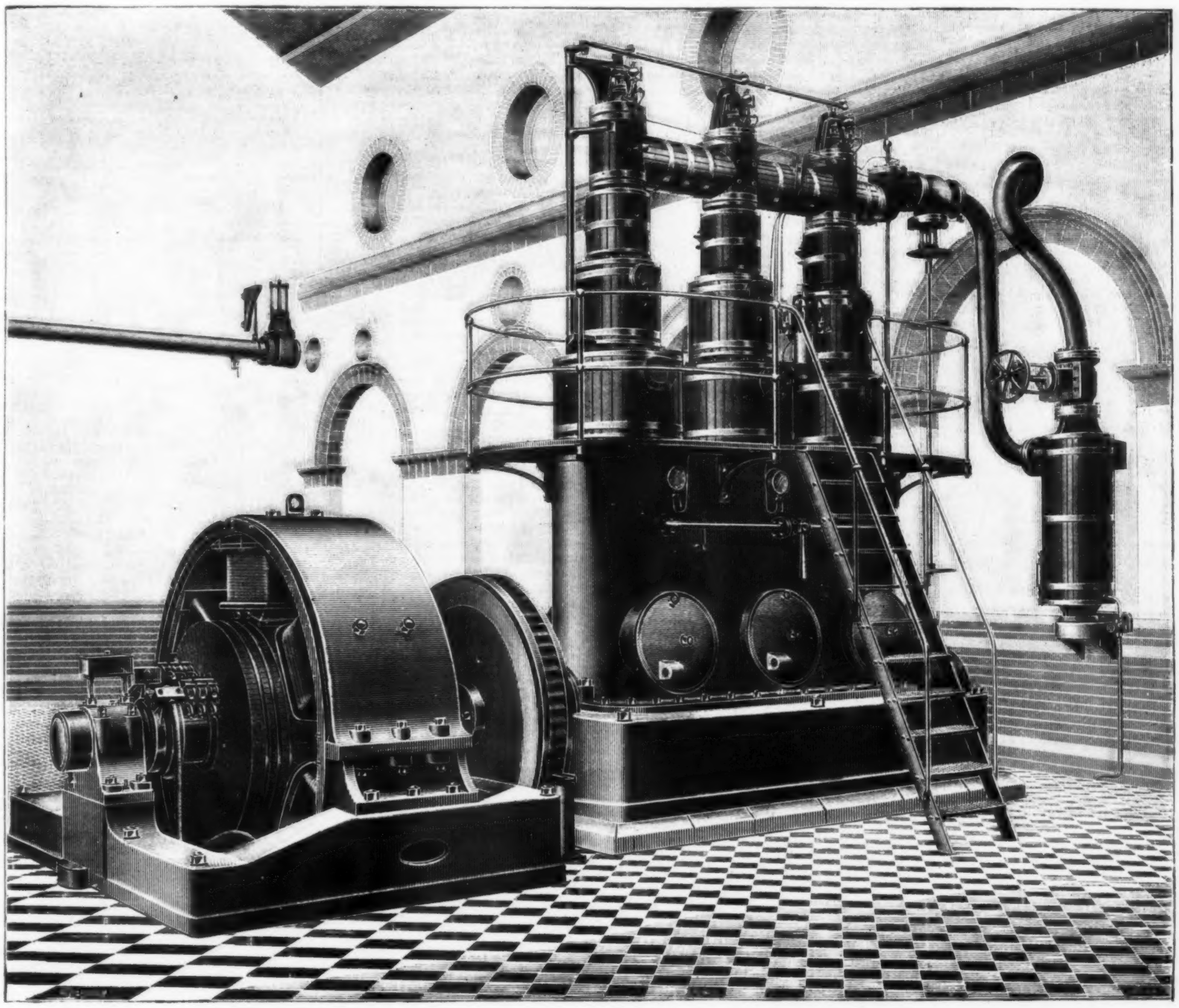
Scientific American, established 1845.
Scientific American Supplement, Vol. XLV. No. 1148.

NEW YORK, JANUARY 1, 1898.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

ENGINES AND DYNAMOS FOR BRADFORD ELECTRIC LIGHT STATION.

THE Bradford Corporation employs fifteen Willans engines and one Marshall engine in its electric lighting stations. These engines are coupled direct to Siemens dynamos. One of the Willans engines, with the dynamo attached, is illustrated below. It is one of two erected in the new Bradford station opened on October 8. The engine is of the well known Willans central valve type, and is triple expansion and condensing. It has three cranks at 120° apart. The high pressure cylinders are 12·6 in. diameter, the intermediate 19·7 in. diameter and the low pressure 30·3 in. diameter; the stroke is 11·4 in., and the speed 300 revolutions per



ENGINE AND DYNAMO, BRADFORD ELECTRIC LIGHT STATION.

minute. The engine was specified to give 300 indicated horse power, but is capable of giving 700 indicated horse power continuously. The boiler pressure is 180 lb. per square inch, but the boilers can be worked up to 200 lb. if desired. The governing is carried out by the Sankey automatic cut-off gear, the cut-off being effected by means of sleeves having diagonal ports, encircling the H. H. P. trunks. These sleeves are connected together by a rod, and are worked by an independent steam relay cylinder of small size (this cylinder is not shown in the engraving). The relay cylinder can be disconnected and the point of cut-off varied by hand if desired. There is a pointer, with index, to show the point at which the cut-off is taking place. A steam separator to catch any water carried over from the boiler is attached to the wall. Teeth are provided in the fly wheel for barring purposes, but as the engine has three cranks, it will start in almost any position. A sight feed lubricator, having separate feeds supplying oil to the three lines of cylinders and to the throttle valve, is fitted between two of the intermediate cylinders. The cranks run in a bath of oil and water, and lubricate all the lower moving parts automatically.

The dynamo is of the Siemens multipolar type, and is coupled direct to the engine. It gives an output of 750 amperes and 500 volts, at a speed of 300 revolutions per minute. The armature is of the usual Siemens drum pattern, with stranded bar conductors, but the diameter in this case is nearly twice the length of the pole pieces. The commutator has 211 segments, and there are two sets of brushes placed at 60° angular distance apart, each set consisting of three brushes. The armature resistance from brush to brush is less than one hundredth of an ohm. The weight of the complete armature is 6½ tons.

There are six field magnets arranged equidistant, inside a heavy forged iron ring, which forms the common yoke, and which is 8 ft. in diameter over all. The pole pieces are rather more than 2 ft. across, and the wire is wound on a wooden frame. All six magnet coils are connected in series, and have a total resistance of 41 ohms. They are connected in shunt to the armature, with an interposed regulating switch and resistance. The whole ring of magnets weighs 11 tons, bringing up the weight of the entire dynamo, inclusive of bed plate, to rather over 21 tons.

At the trial held at Messrs. W. Willans and Robinson's works, Rugby, in the presence of Mr. Gibbings and Messrs. Siemens' representative, the consumption of steam was as follows:

	Vacuum.	Revolutions per minute.	Consumption per I. H. P. per hour. Actual.	Guaranteed.
Full load	21 in.	299	13·5	14
Half "	23 "	299	14·2	14·5
Quarter	24 "	300	15·0	15

The poor vacuum was due to insufficiency of cooling water. The engine and dynamo were constructed to the specification of Mr. A. H. Gibbings, engineer to the corporation.—Engineer.

WIRE.

THE earliest forms of wire were hammered from rough bars. This crude way was superseded later when it was discovered how to draw, and this method of wire drawing is now universally applied for wires of any material. In the case of iron wire the metal is first converted from "blooms" to "billets" and from "billets" to rods at one heat. This is accomplished by a long train of rolls which pass the rods from one to the other. The rods average from 2 to 600 yards in length. Very large sizes of wire may be made by continued rolling of the rods.

The rods thus produced by rolling in the heated state are made into wire by the process of "cold drawing." By this process the rods of iron or steel, rolled several hundred yards long, are first pointed at one end by hammering or by a special machine, and are then cleansed by washing in a bath of dilute sulphuric acid or hydrochloric acid, and afterward are immersed in lime water to give a drawing surface. After drying by heat they are ready for the drawing mill, which consists of a series of horizontal drums or pulleys, 10 to 30 inches in diameter, termed "blocks," mounted on vertical axes on long benches. Accompanying each drum are drawplates and pincer drawers. The drawplates are disks or blocks of cast steel drilled with tapering holes, the small ends of which correspond exactly to the size of wire to be drawn from it. The form of the hole, of course, determines the form of cross section of the wire, which is usually circular, though not neces-

sarily so. When the holes become worn from use and depart from their original gage, the metal is hammered around the small end, closing it, after which it is reamed out to standard size. Where great uniformity of gage is required, as in fine gold or platinum wire, perforated rubies or similar hard minerals are fitted in the drawplate. The drawplates are clamped in vises fixed to the bench. As the tapering end of the rod is inserted in the hole of the plate, mechanical pincers seize it and pull it through. The pincers are fixed on horizontal arms, which are moved backward by cams fixed on the axes which rotate the drums. The wire as it is pulled through by the pincers is wound on the drums. The bottom of the drum is fitted with recesses to correspond with projections on a cam mounted on the same axis. The drum can be raised so as not to be in contact with the cam and then may be turned freely on a spindle. When enough wire has been drawn through the drawplate by the pincers to make one turn round the drum, the wire is taken from the pincers and fastened to the drum, which is lowered, and the cam fitting in its base turns it and winds the wire upon the drum. The drums draw from 500 to 700 feet per minute for ordinary wire and somewhat slower for crucible steel. The wire has now been drawn down one size, reducing the diameter about 10 per cent., and the process is continued until the proper gage is attained. It is said that copper wire may be reduced 15 sizes at one drawing. In continuous wire drawing several drums are placed in line on a frame, so that the wire winds on and off each one successively. Between the drums rotating disks, made of some extremely hard substance reamed out to size, are placed so that the wire passes through them. The holes in the succeeding disks are smaller than those in the preceding ones. Thus the cross section may be reduced a number of sizes in one operation. Of course, the speeds of the drums are proportional to the elongations produced by the reducing of the diameter of the wire, and have to be very exactly regulated, so that there may be no undue stretch or slack between the drums. The drawing is facilitated by the application of lubricants; a kind of grease for the larger grades and liquids such as soapy water and milk for the smaller. Where a straw colored wire is not objectionable a weak solution of copper sulphate is used as the drawing liquor. These lubricants coat the wire with a mucilaginous or metallic film, so as to preserve it from oxidation and leave a polished surface.

Wiredrawing increases the hardness of the metal so that the wire has to be frequently annealed during the process. In practice, fine wire is thus softened six or eight times. The annealing pots consist simply of metal chambers into which the wire is placed, and the pot is then hermetically sealed. The process of heating requires several hours at a red heat, a temperature of 600 to 700° F. being best. The pots and their contents are then allowed to cool slowly. An average charge for a pot is two and a half tons of wire.

When unprotected iron wire is stretched in the open air and exposed to the elements, it loses in time a large part of its strength and conductivity, owing to oxidation or rusting. This oxidation is very noticeable in large cities and along railroad lines, on account of the atmosphere being charged with acid gases arising from the combustion of coal. In Pittsburg, for instance, a plain No. 9 wire is worthless in a few years, while on some country routes in New England the same wire has been in use thirty years. To prevent this oxidation it was formerly the plan to dip the wires while red hot in linseed oil, but galvanizing is now universally employed for this purpose. By virtue of the positive properties of zinc, it is attacked on contact with the air, or carbon dioxide, and the iron or steel wire is protected. In some instances, however, the wire is tinned.

Steel commonly used in the wire trade contains from one-tenth to one per cent. of carbon. Four-tenths per cent. of carbon in the steel used would make steel spring wire, five-tenths ordinary wire rope, and six-tenths of one per cent. piano wire. Where toughness is required the per cent. of manganese may range as high as seven-tenths of one per cent.

In America size 0000 is the largest and 40 about the smallest in ordinary work. If a size larger than 0000 is required, a cable composed of several wires is used. Much finer than size 40 is used for special purposes, as in telescopes and optical instruments, where the wire is much finer than a silk fiber. A human hair is one five-hundredth of an inch in diameter, while platinum has been drawn down to one seven-thousandth of an inch, and by coating with silver and drawing and then dissolving the film of silver with acid, fibers of platinum one fifty-thousandth of an inch in diameter have been obtained.

The variety known as improved steel wire implies that which has been treated by a patented process of annealing, hardening and tempering, by which the wire may have its tensile strength increased without impairing its ductility appreciably, but usually at some sacrifice of toughness. The tests of the quality of wire include, besides those for tensile strength, a number to determine its ductility and elasticity. It should be capable of being bent forward and backward at right angles to itself a certain number of times without breaking. It must be capable of being wound around a wire of its own diameter a certain number of times without showing signs of splitting, and it should be able to bear a certain number of twists in a given length without splitting. The elongation is also important, particularly in wire for telegraph use, where the specifications call for from 12 to 20 per cent. elongation.

The process of wiredrawing greatly increases the strength of the material from which it is drawn. Thus it has been found possible to temper steel wire to sustain a load equivalent to 190 tons per square inch, while 70 tons is considered large in test pieces of hard steel. Such wire, however, is not of practical use, because it is exceedingly brittle, and the brittleness increases very rapidly in proportion to the strength toward this limit. A strength of 150 tons is considered the greatest that can be combined with the essential ductility and elasticity. The finest wire in respect to temper is that used for pianos. A competition test for this class of wire was given at the Centennial, of 1876, the best being exhibited by Pohlman, of Nuremberg, the city where wiredrawing was first practiced; the best makers of America being far behind at that time. While ordinary telegraph wire made from charcoal puddled bars and Bessemer or Siemens steel gives a torsional efficiency of 15 to 20 twists in a 6-inch length, with 20 to 30 tons strength, an average of a large number of specimens of Pohlman's wire resisted 60 to 70 twists, and broke at 140 tons. Single specimens withstood 100 twists.

Copper wire is manufactured by rolling ingots or billets into rods in the hot state, and drawing them as in the case of iron wire. Its great superiority over iron in conductivity and its freedom from electromagnetic induction give it an immense advantage for electrical uses. Its greater price per ton is compensated by its lesser weight per unit of resistance. It has been shown on a copper and iron line 278 miles in length, whose resistance and capacity were rendered equal, there was an increase of speed of nearly 13 per cent. as compared with iron wire. Though a large part of the telegraph service is supplied with galvanized iron wire, copper alone is employed for the long distance telephone, the electric light and the transmission of electric energy.

Of the other metals and alloys employed in the manufacture of wire, the most important is silicium bronze. This alloy was patented by Weiller, of Paris, in 1882, and is formed by adding silicium and sodium to copper in a certain manner. The properties of this metal show a conductivity of 40 to 98 per cent. that of copper—three to six times that of iron, although only one-fourth the weight—and tensile strength nearly equal to that of steel. It will not oxidize readily, and will therefore last almost indefinitely, and in France is rapidly superseding iron and steel in electric transmission. It may be made of varying strength, but its conductivity rapidly decreases as it approaches its tensile limit. That recommended for telegraph wires is an alloy showing a conductivity of 80 per cent. that of pure copper and a tensile strength of 35 tons. When iron is used the conductivity is 16 per cent. and the strength about 25 tons, showing the silicium bronze to have five times the conductivity of, besides being much stronger than, ordinary telegraph wire, weight for weight. With a strength of 50 tons it still shows a conductivity two and a half times that of iron.

Aluminum is not regarded as a useful metal for wire manufacture, its tensile strength in this form being only 10 tons, and elastic limit very low. Experiments made in Berlin show that neither carbon nor silicon interferes with the conductivity of wire, but phosphorus and manganese decidedly lower this property.

Torsion also influences the conductivity, and the resistance increases thirty-five hundredths of 1 per cent. for each additional degree Fahrenheit, making a difference of 15 or 20 per cent. between summer and winter in some localities.—A. L. Orton, in Sibley Journal of Engineering.

PLASTER CASTS AND OTHER METHODS OF MOULDING SHELL FORMS.*

By John C. Knoeppel.

The art of constructing plaster casts for the purpose of taking off patterns in metal belongs more to the pattern maker than to the foundryman. The moulder is not expected to learn this branch of the trade, as it is not universally practiced and probably not understood by many engaged in foundry work, being more in the line of pattern work.

This form of pattern making is very simple and inexpensive, yet very precise and accurate, especially so on irregular work, as patterns that require backing out, such as for deep figured, carved and ornamental designs. To properly back out a pattern so as to make it the required thickness and at the same time produce an even pattern requires great care and tedious labor. We all know that to make patterns for shell forms of any size or shape requires much time and in many cases untrue or uneven patterns are the result, when built of lumber, causing considerable trouble to the foundryman in using the same in sand on account of their being warped and out of shape.

In making patterns in plaster we first have the outer form made of wood in a block shape. Sometimes this outer part is made of plaster by the aid of suitable sweeps and having such ornamentations and figures thereon as are called for by the designer. When the pattern is completed, have a true board made with battens on and tongued on to the end to keep it from warping. Fasten the block to it with screws from the under side, varnish the same and allow it to dry. Then have a flask made for the purpose with an extra nowel part, properly fitted with pins and eyes alike and to suit pattern board.

We are now ready for the plaster cast. Put the pattern board on a bed of sand, fitting the extra nowel to it, and clamp the same. Before pouring in the plaster oil well the pattern and board, olive oil being preferable. Now mix the plaster of Paris with water sufficient to give it the consistency of thin mortar, so that it will find its own way to all parts of the pattern and of sufficient quantity to fill the nowel, allowing it a short time to settle, then strike off and put on a bottom board and secure with screws. Mixing a little parting sand with the plaster hardens it, and it will dry quicker and have less blow holes and bubbles. After a lapse of fifteen or twenty minutes, roll over the plaster cast and unscrew the pattern from the board, taking off the board, the pattern proper still remaining in the plaster. Rap carefully and draw it out of the plaster. You now have an impression the reverse of your pattern. While the plaster is drying take the block pattern and put it back to its original position, being careful to clean it well before using it for moulding from. At this point you have a concave and convex form of pattern. The plaster cast should be allowed to dry for at least fifteen hours, but could be dried in less time with moderate heat.

We are now ready for filling up the thickness in the plaster cast. Have a true board made, with strips of the required thickness fastened to it at each end. This board should be about the size of a kneading board, such as is used in our homes. Mix up composition of whiting and melted beeswax to the consistency of stiff dough and with a rolling pin roll out suitable sheets, cutting them into different sizes to suit the work, laying and pressing them carefully in and against the surface part of the cast, using suitable tools, the hands and fingers coming into play frequently. Secure the filling with tacks.

This filling or thickness composition should be put only where the pattern line shows; all of it should be well varnished, and when dry proceed to mould.

Take the bottom board and pattern, place the nowel for the purpose upon it, being careful that there is no shift, and fit into the pins on board tight; ram this up with sand in the usual way, treating the mould as you would in every case, clamping the same as in the case of pattern making or moulding. Roll over on the bed and unscrew the pattern from board, taking it off; draw out the pattern proper and finish in the usual way; then proceed to the cope part. Take the plaster cast and place the cope on it, using the same precautions as with the pattern. Provide suitable gates for pouring and ram this part up with sand also. Roll over, being very careful not to disturb the mould in drawing the cast off the cope. Finish as usual.

We now have both nowel and cope part. Close these two parts together, marking the gating points with flour; take off the cope again, cut the gates, reclose flush and clamp up. When you are ready for the metal, before closing for the last time, be sure that the parting line meets. A little flour will help to fill up if a little slack, thus producing an economical as well as a very true and reliable mould. Sometimes a right and a left form are necessary, such as for heads, birds, animals and statuary, to produce a full form. In that case both sides are made in the manner described above.

While at work some years ago in one of the Western foundries a large number of these patterns were broken and patched so much that they made heavy as well as unsightly castings. The original could not be had, and of course could not be duplicated. I then suggested plaster casts and the work was given me. Using the regular patterns to work from, the first cast was reduced about 10 pounds over the old one. The result being satisfactory, I was given more to make up, due allowance being made for shrinkage.

A large variety of subjects can be made in plaster, and when once acquainted with this branch, many lines can be pursued for plumbers' work, tees, elbows, branch pipes, hoppers, etc. These casts can be preserved for future use or a number of master patterns may be taken off and stored.

Another good way to take off block patterns is by stripping. While it is not as accurate and precise as the plaster cast, yet it will answer in many cases. The plan is similar to that mentioned, but, instead of plaster, we work the block directly with sand. The block is made and secured to a true board, as in the case of plaster casts. A cope is fitted to it, and rammed very hard with common sand and rolled over. The board is taken off and the pattern drawn out. Suitable wooden strips are cut to conform to the work and of the required thickness. Now have sufficient paper on hand, cutting the same into suitable strips, and lay it on the surface of the mould and nail the paper to the sand until the required thickness is obtained. Then commence laying on the wooden strips, these being cut large or small as required. After all is filled up even with the joint, fill in with fine sand. This might be done while laying in the wooden strips to keep them from falling out of place, being careful not to disturb any part of the mould. Then place the nowel upon the cope and ram up in the usual manner, roll over carefully and take off cope. The cope is what we term a false coping and is shaken out. After cleaning off the pattern, prepare the cope in the usual way. Put it on the pattern board with block fastened thereon, clamping and setting the gate pins and ramming up with sand. This needs to be treated differently from the first case, not ramming too hard, and in the regular way, as in the course of moulding. Roll over, take off the board and draw out the pattern. Now finish both parts, nowel and cope. When completed, close cope on the nowel, put a little flour on the joint with a bag, lift off and see if joints touch and meet and join securely; see if you have even thickness; then close again and the mould is ready for pouring.

Almost any form of work can be made in this manner, of a smooth character, such as kettles, pipes, drum tanks, bathtubs, etc.

Still another simple way is to make a core the desired shape with a sweep, drying it, and then with the thickness strips lay on the core and ram up.

A few years ago I made a steam receiver with reducing end and flanges, 30 inches in diameter, 10 feet long, reducing end being about 20 inches, weighing about 5,000 pounds. The party wanted only one casting, and it would not pay to go to the expense of making a pattern. I proceeded as follows: Sweeps were made to conform to the shape at each end and at the center. A skeleton frame was also made and was laid on core plates made in halves and dried, with proper core irons, having suitable holes drilled and threaded to handle them in lifting. I placed one half on mould board, placing the flanges at each end, and having the thickness strips ready to lay on the core and rammed up in the usual way with sand; rolled over and made joint. Put on the other half core, and stripped it as in the nowel, being careful that they corresponded with each other. Put on the cope and set the gate pins and rammed up. After lifting off we took out the cores and returned them to oven for redrying, finished the mould, setting chaplets and resetting cores, said cores providing their own prints. This was cast in green sand and turned out very good.

* A paper read before the Western Foundrymen's Association.—From The Iron Age.

Selenium has not hitherto played any very important part in commercial industries; it has been chiefly known in the chemist's laboratory as a curious and interesting substance possessing no specially useful properties. It has recently been employed in the glass-maker's pot for producing colored glass. Rose tinted glass is made by adding selenium directly to the ingredients in the melting pot, the depth of tint depending entirely on the quality used, and also to some extent upon the character of the glass—whether it be hard or soft. A lovely orange red color is produced by mixing cadmium sulphide with the selenium before adding to the contents of the pot. The intensity of the yellow constituent in this case depends directly upon the proportion of cadmium sulphide made use of. A practical advantage attending this process is that it is not necessary to reheat the articles after being manufactured and to dip them in a coloring mixture, as in the ordinary process of making red glass.

[Continued from SUPPLEMENT, No. 1147, page 18332.]

THE COMPARATIVE ADVANTAGES AND DISADVANTAGES OF STEAM, COMPRESSED AIR AND ELECTRICITY FOR POWER PURPOSES IN COAL WORKING, WITH SPECIAL REFERENCE TO COAL CUTTING AND HAULAGE.

(The Iron and Coal Trades Review Prize Essay.)

By G. E. J. MCMURTRIE, A.M. Inst. C.E., Cinderford.

ADIABATIC COMPRESSION.

THE system of water jacketing generally adopted to reduce the heating in the compressors has not proved satisfactory, owing to the small circumferential area of the cylinder compared with its contents, for even in the case of the Birmingham compressors the air has been proved to leave the main at a temperature of 280°.

This might be supplemented by some system of spray injection, in spite of the increased complication and reduced mechanical efficiency entailed by it, more especially as this water would reduce the waste due to the clearance of the cylinders.

The great objection to it would appear to be that, if the water be gritty and dirty, the rubbing surfaces suffer, and the consequent friction and liability to leakage further reduces the efficiency. Many consequently consider that nothing is gained by it.

The alternative plan is to compress in stages and cool in each case between the stages to atmospheric temperature, which can be done by passing the air through a number of tubular vessels with large cooling surface. Prof. Elliott's figures, too, show that this yields a substantial increase of efficiency, as, though there is the same loss on the first stage, the loss on the second stage is very small, on account of the air being cooled, and the heat lost in compression is much reduced.

This system, together with spray injectors, Prof. Riedler has introduced in Paris, and has saved two-thirds to three-quarters of the work expended in uselessly heating the air, the loss due to heating in compression being in one case only 12 per cent.

SINGLE STAGE COMPRESSION.

In single stage compression at Paris 70 per cent. of efficiency only is got, and, if we allow for friction of mechanism, $0·85 \times 70 = 59·5$. The Riedler two-stage compressor yields 87 per cent. $\times$ $0·85 = 77$ per cent.

This has the advantage, too, of allowing the compressor to be worked at a much higher speed, owing to its being better balanced, and the low rate of piston speed usual in air compressing engines—often only 200 feet per minute—can be increased to 400 feet per minute.

Other suggested remedies for overcoming heating in compression are: 1. That the compressor should not be placed so close to the steam cylinder as is usual in tandem engines, but that as great a length of connecting rod as possible be allowed between them to prevent the air drawn in being air that has been already heated by the steam cylinder. 2. That the compressing cylinders be placed outside the engine house and simply protected by a shed. 3. That the air taken in by the engine should first be reduced to zero by the use of freezing mixtures.

In order to recover part of the power lost in compression, due to the latent heat liberated in the act of compression, it has been proposed that the motors should be compounded or tripled, and that the air should be cut off in each motor and allowed to expand, which would cause the temperature of the exhaust to be below the atmospheric temperature.

If this air be allowed time or opportunity to take up the atmospheric temperature again, some part of this latent heat would be regained in each motor, and this heating would increase the pressure of the air in each motor.

In the Paris installation artificial heat has also been adopted, the air being passed through a simple form of stove before being admitted to the motor.

Prof. Riedler heated the air going into an 80 horse power steam engine to 300° F. with 15 pounds of coke per hour only.

This use of artificial heat is a practical impossibility in all but non-fiery collieries, and without it the efficiency of compressed air must remain low.

Prof. Unwin has stated that jacketing the air motor cylinder with hot air has been tried in some cases, and lately in other cases water has been injected in small quantities into the air while passing through the reheating stove and is thus converted into steam.

It condenses during the expansion, yielding latent heat to the air, and so raising the temperature of the exhaust. It lubricates and prevents leakage.

COMPOUND SYSTEM OF MOTORS.

The compound system of motors may overcome the following difficulties:

1. The rapid decrease in efficiency attendant on increase of pressure, which has caused low pressures alone to be used, and has necessitated larger compressors and pipes.

2. The small ratio of expansion in ordinary motors.

3. The formation of ice in the exhaust passages of the motor. Much of the water in the air will be condensed under the action of cold and pressure in the receivers, whence it can be blown out, but short exhaust passages with ample area will largely prevent this formation of ice.

In addition to losses by heating, clearance and leakage past the piston, there is frequently a large loss at the air valves when automatically controlled. This loss is largely removed by the use of positively controlled valves, such as the Riedler valves, which are controlled by some rocking motion similar to the reciprocating motion of a slide valve. This allows the valve to remain open till near the end of the stroke and to be then closed quickly by the action of the valve gear.

They are provided with a cushion, which, while giving a free opening, prevents them opening too wide. Automatically acting valves are liable to irregularity, and give but a small lift, necessitating additional valves and a slow speed to avoid breakages and wear and tear. The Riedler valve insures a piston speed of 300 feet to 500 feet per minute, and consequently a smaller compressor is needed.

In concluding this part of his subject, the writer would draw attention to the following data in confirmation of Prof. Elliott's figures.

EFFICIENCY OF NEWER MOTORS.

Prof. Riedler found that while the efficiency of the older motors was but 37 to 44 per cent., in newer motors, working expansively, 58 to 87 per cent. was got, and with reheated air more than this. An 80 horse power Farcot engine, with air reheated to 300° F., jacketed with hot air, gave 81 per cent.

The efficiency of the process of compression alone was found to be in old single stage compressors as low as 50 per cent.; the single stage compressors tried by Prof. Riedler gave 70 per cent. and the two-stage ones gave 90 per cent.

Considerable changes in the initial pressure and velocity in the mains affects the efficiency but slightly, and we can get, Prof. Unwin tells us, when passing 10,000 indicated horse power, an efficiency of 44 to 51 per cent. in compressors, main and air motors, with the air used cold and with small mains. If we reheat at the motor, we get 64 to 75 per cent., neglecting the cost of fuel for reheating.

Prof. Robinson, experimenting at Birmingham on thirty-four motors worked by compressed air at 45 pounds above atmospheric pressure, found the average efficiency to be 42 pounds. In some cases the air was used expansively, and was heated before utilization. On improving certain defects, the efficiency rose to 45 per cent.

In another case a 40 horse power engine, worked by compressed air heated to 280°, was tested and found to yield 73 per cent.

The following table also is the result of experiments made in 1874 with simple motors and simple compression by Messrs. J. Fowler & Company, of Leeds, who have had considerable experience with air compressors:

Gross Efficiency of Compressed Air in the Transmission of Power.

Air Pressure in Pounds.	Efficiency = Brake H. P. in Motor. / I. H. P. of Compressing Engine. Per cent.
40	25·8
34	27·1
28·5	28·5
24	34·9
19	45·8

EFFICIENCY OF ELECTRICITY AS A MOTIVE POWER.

In a paper recently read by Mr. Robertson before the Institute of Civil Engineers, he said that in the electrical haulage plant put down at the Earnock colliery an efficiency of 50 per cent. was shown. Comparing the indicated horse power of the engine and the power developed on the rope, the losses were made up as follows:

	Per cent.
Loss in engine	22
" " belt and dynamo	8
" " cable	12·5
" " motor and gear	7·5
Total loss	50

Mr. I. Meachem, Jr., has given the efficiency of an electric haulage plant that he has lately put down at the Haden Hill colliery at 59 per cent. Comparing the indicated horse power delivered to the generator and the power delivered on the ropes, the losses were as follows:

	Per cent.
Dynamo	9
Cable	8
Motor	9
Gearing	15

The first pumping plant put down at the St. John's colliery, Normanton, was tested by Mr. A. T. Snell, and found to give 44·4 efficiency, comparing the indicated horse power of the engine and the theoretical horse power in water raised to top. This plant delivers 39 gallons of water to a height of 530 feet.

Mr. L. B. Atkinson, in a discussion at Cardiff, instanced a 300 indicated horse power pumping, winding and hauling plant (sent out, the writer believes, to the De Beers mines) yielding 45 per cent. efficiency, comparing the indicated horse power of the steam engine and the actual water pumped, the actual power developed on the haulage rope, and the actual power delivered on the winding engine rope.

The following is a test of the St. John's second pumping plant, made again by Mr. A. T. Snell and Mr. E. Brown. In this case, 120 gallons of water were pumped a height of 900 feet, and an efficiency of 43·1 per cent. was obtained, a result very similar to that got from the first plant.

The percentages of losses, as calculated from the indicator cards, are as follows:

	Per cent.
Engine friction	9·4
Belt and dynamo friction	6·5
Leads and motor	9·4
Motor belt	14·0
Motor belt gearing and pumps empty	43·1
Water friction in pumps and rising main	17·6

At the Comstock lode, Virginia City, Nevada, with the generators driven by water power, a yield is got on the main mill shaft of 70 per cent. of the water power applied to the dynamo shaft.

Mr. Atkinson, too, in the paper before quoted, claimed for electricity an efficiency of 50 per cent. of the power put into the engines, and sometimes 75 per cent.

Messrs. L. B. and C. W. Atkinson, in a paper read before the Institution of Civil Engineers on electric mining machinery, gave the following tables of efficiency of a pumping plant, showing a gross efficiency, comparing the indicated horse power of the engine with the water delivered, of 49 per cent.:

Distance engine pumps, yards	1,200
Indicated horse power of engine	31·75
	Per cent.
Loss in engine and belt	31·5
" " dynamo	6·05
" " cable	5·36
" " motor	4·72
" " pump and gear	3·15

They give a further table comparing the transmission for 10,000 yards of compressed air and electricity, the compressed air figures being based on Prof. Kennedy's experiments at Paris and those for electricity on well authenticated trials of motors and dynamos:

	Size of Pipes.	Engine B. H. P.	B. B. H. Motor / B. B. H. Engine.	Cost Complete and Erected. £.
Air	3	62·1	16	2,500
"	4	39·0	26	3,100
"	5 and 4	35·8	28	3,448
Electric	$\frac{12}{17}$	19·2	52	1,580

Comparing the efficiency of compressed air and electricity, we find that a number of careful tests show an efficiency of 45 per cent. to 50 per cent. for electricity, comparing the indicated horse power of the engine with the delivery of water, or the actual work delivered on the rope. With compressed air, taking Prof. Elliott's figures again, we get:

	Per cent.
With simple compressor and simple motor	31·28
With compound compressor and simple motor	35·92
With compound compressor and compound motor	40·56

And it is to be remembered that although these are not results actually obtained from tests of plants, yet they agree well with Prof. Kennedy's and Prof. Riedler's figures, and are, as was to be expected, higher than Messrs. J. Fowler & Company's. As single compressors and motors are almost universally used in this country, we may take it that electricity has a higher efficiency of at least 20 per cent., and probably 30 per cent.

Figures as to the cost of plants are most conflicting. At Earnock colliery the initial cost of a compressed air plant was found to be much greater than that of an electrical plant to do the same work.

The table calculated by Messrs. Atkinson showed the cost of the compressed air plant to be at least double that of the electrical plant. The low efficiency of compressed air means a larger engine and more costly generating plant, while the pipes, too, are very costly. Thus, on grounds both of efficiency and of first cost, electricity would appear to the writer to be preferable.

The ease with which electric cables can be taken long distances underground, and the ease with which they can be fixed, is greatly in favor of electricity, as is also the cost of the cables compared with the first cost and cost of fixing of compressed air pipes. Movements of the floor, with consequent leakage and breakage of the pipes, further handicap compressed air. The great drawback to the use of electricity is the possible danger of explosions in fiery mines, from (1) breakage or short circuiting of the cables, (2) sparking at the dynamo. The first can be guarded against by armoring the cables with galvanized iron wire or with a lead covering, and by using nothing but thoroughly well insulated cables. One plan is to have concentric cables, the inner being thoroughly insulated, and the outer protected by armoring, but uninsulated. In case of breakage of the cable, short circuiting would follow, the cut-out would be fused in the generator house, and the current stopped.

It seldom happens that cables fastened to the side are broken; a fall in the road would probably break them down, but their strength is generally too great to fail.

To prevent damage to the cables on the road, they are frequently buried, but the danger of this arrangement would appear to be that damp might affect and in time eat through the insulator, and permit loss of current. In the shaft, cables are generally well insulated with gutta percha, which should always be used where roads are wet—compound braided, incased in lead, and either let into wooden troughs, the covers of which are screwed on, or placed inside iron pipes with junctions at intervals. Sparking may take place at the brushes, commutator, armature and switches. The brushes, commutator and armature should be incased in an airtight metal casing, connected to earth, so arranged, if possible, that the brushes are removed with the cover should the casing be taken off. No sparks can get out of such a case, and should gas get in, it will burn quietly, while in case of explosion the box would be strong enough to resist it. A spark with an energy of 20 watts is required to ignite pit gas, and this cannot be got without great displacement of the brushes, or heat being generated sufficient to form an oxide of copper; and so much metal is put into the armature, to prevent heating, that some considerable time would be required to produce the necessary heat. Alternate current motors also prevent or largely reduce sparking at the dynamo, having neither commutator nor brushes; but they are difficult to start, the risk of shocks is twice as great, and the area of cable required just double that needed for a continuous current motor, while the efficiency of such motors rapidly falls except at the normal speed, and they are liable to lose their current without any warning. The switch should also be incased in an airtight box connected to earth, or, in the case of a series wound dynamo, a resistance coil of small self-induction should be connected to the ends of the magnetizing coil, and the switch also so arranged that before breaking the circuit the coil of the magnets is short circuited. A resistance coil, too, connected to the several points with which it makes contact, is added to the lower side of the switch, so that if even the generator is short circuited the current is so little that it is less than the critical magnetizing current of the dynamo.

Good ventilation is the best safeguard. What would doubtless add to the efficiency of electricity is using high voltage in place of low, but, on account of fear of accidents, this is limited to 400 to 500 volts. If a high voltage is used in the cables, a transformer also is used to bring it down to a low voltage at the motor, and this reduces the efficiency 20 per cent. On long circuitous routes, in conveying power for small auxiliary haulage, electricity is most convenient. Another advantage it has is that the generators may be concentrated in one engine house, with a single man to supervise them. A third advantage electricity has is the small size of the motor relatively to the power developed. The cost of repairs compared with those necessitated by the use of compressed air is very small, and chiefly consists of fresh brushes and wear and tear on the armature. A set of brushes will often last six

to twelve months. Although increased pressure, as shown by Prof. Unwin's figures, reduces but slightly the efficiency of compressed air, yet the cost of the pipes is so great relatively to the cost of cable that it cannot compete with electricity for extensions of haulage. Moreover, the resistance of the electric cable is a known quantity, and increases very little with distance.

SPECIAL ADVANTAGES OF COMPRESSED AIR.

The exhaust of the air motor assists ventilation, and for driving stone branches, tunneling, and opening up abandoned roads, and in case of explosion it is invaluable. At many collieries large sums of money have thus been saved. Not only, however, does electricity yield a largely increased efficiency at probably half the first cost of a compressed air plant, but on account of the ease with which the cables can be extended, on account of the relatively low cost of cables and fixing, on account of its independence of floor movements, and low cost of repairs, the writer would recommend electricity as the motive power for extended haulage, especially as the same power could be utilized to light the pit top and bottom, the stables and the principal haulage and pumping stations, it being his belief that, with proper precaution, no danger need arise from breakage of cables or sparking at the motors. The great cost of carrying steam 2,000 yards inby, with the large condensation that must ensue, however well covered the pipes may be, together with the consequent heating of the intake air and the difficulty of dealing with the exhaust steam, especially if there is no water obtainable, would render the use of steam most inadvisable, if not an impossibility. For pumping, the writer would again recommend the use of electricity, on the grounds already fully stated, three-throw pumps being placed both in the pit bottom and wherever any considerable quantity of water was met with. Should a number of small feeders have to be dealt with, the same motive power, with suitable pumps, might be arranged to pump to some central station, whence a three-throw pump, driven by electricity, would send the water on to the hold out of which the main shaft pump draws its water. If only a small quantity were met with, and close to the haulage plane, it would probably be best to apply a rope to a small pump, and to wind the water up the 600 yards shaft. The efficiency of this power at the Carlin How mine is stated by Mr. A. L. Steavenson to be 44·37 per cent. when raising 127 gallons a total height of 146·5 feet.

Should electricity be applied to a number of pumps, it would be necessary for the dynamos to be over-compounded, so that the pumps might all be worked together, or any stopped or started without affecting the speed of the others, especially if the light is obtained from the same dynamo or dynamos. By this means a constant pressure would be got at some point near the center of the system, and an almost constant pressure obtained all over the system.

COAL CUTTING MACHINERY.

As yet, coal cutting by machinery has made no great progress in this country, although there are cases recorded where the introduction of coal cutting machines has prevented a colliery being closed, as, for instance, the Lidgett colliery, near Barnsley.

The principal machines in use in this country comprise the Gillott & Copley, the Regg & Meiklejohn, the Stanley, the Blackburn, the Goolden and the Jeffrey.

Machine coal cutters are more largely used in America, and among the best may be named the Mitchell Longwall, the Jeffrey, the Regg, the Ingersoll-Sergeant, the Harrison, and the Yoch, the latter three being percussive machines of light weight and handy form.

The Gillott & Copley, the Regg & Meiklejohn, and the Stanley have hitherto been worked by compressed air, while the others have been driven by electricity and compressed air.

A combination of the Gillott & Copley and the Regg & Meiklejohn, driven by electricity, has lately been tried with success at the Glenclelland colliery.

It is not the purpose of this paper to discuss the different types of machines, or the relative advantages of those machines, but the author would state briefly that, among many advantages, an economy of 5d. to 6d. per ton in labor cost is claimed for them when used at the coal face, together with 15 to 30 per cent. increase of large coal in place of slack, and double the output of coal from a given face, thus reducing the face room to one-half and the roads and airways to probably three-quarters their present length.

In no branch of mining can electricity, in the writer's judgment, claim greater advantages over compressed air than in coal cutting. The great network of pipes, which in a large colliery comprises many miles, must entail great leakage, especially as they require to be laid in roads that are still on the move. The handiness of electric cables, and the ease with which they are fixed, compared with the cost of laying pipes, is, as has been before stated, very much in favor of electricity.

There can be little doubt that the expense and trouble caused by compressed air has greatly retarded the introduction of machine coal getters.

Excepting the application of electricity at Glenclelland colliery, and the Jeffrey machines driven by electricity recently put down at the Cannock & Rugeley collieries, the type of cutter driven by electricity has been the bar, either taper or parallel.

In the improved form adopted by Goolden the bar is drilled with a series of holes, each of which is placed in a direction nearly at 90° to the next adjacent one, but differing so far from a right angle that one complete turn is made in the length of a bar. Thus a left-handed spiral is produced, with a pitch equal to the length of the bar, which serves to equalize the cutting action, and also a right-handed spiral, which has a pitch equal to about one-sixth of the bar, and forms a kind of cork screw to draw the dust out of the cut.

Mr. L. B. Atkinson has advocated the use of series wound dynamos and motors, on the important ground that when the motor is stopped by the insertion of a proper resistance the electromotive force may be reduced nearly to zero before breaking the circuit, and that there is no liability to shock should the insulation at any point be defective. A shunt-wound motor would give a more constant speed, but would not be so good for starting.

The motors and switches are in every case inclosed as before described, as it is at the coal face where gas should, if anywhere, be met with.

The gearing and all bearings to which grit might get access are also inclosed, and the gear itself revolves in oil.

Special brushes have to be adopted to get over the excessive vibration to which the machines are subjected, although there is less than with compressed air.

A further advantage of electricity is that there is not the noise inseparable from compressed air, which at a coal face is a matter of very great importance.

Should a cutter bar get jammed, electricity has also this advantage over compressed air, that, just for a few seconds, the motor would exert more than its normal force, and probably liberate it.

In a wet or damp seam it would be difficult to keep the resistance of the armature right, and compressed air, in spite of its low efficiency and trouble, would probably be then advisable.

The author has been unable to obtain any satisfactory comparison of the first cost and cost of maintenance of electrical and compressed air coal cutting plants, probably because so little has yet been done with electrical coal cutters in this country. But, for reasons stated earlier in this paper, he considers that, both in first cost and cost of maintenance, electricity must be less than compressed air, and, except for the possible danger arising from sparking, and the advantage derived from the exhaust, little can be said in favor of compressed air.

CONCLUSIONS.

The author has now considered steam, compressed air and electricity for haulage, pumping and coal cutting purposes.

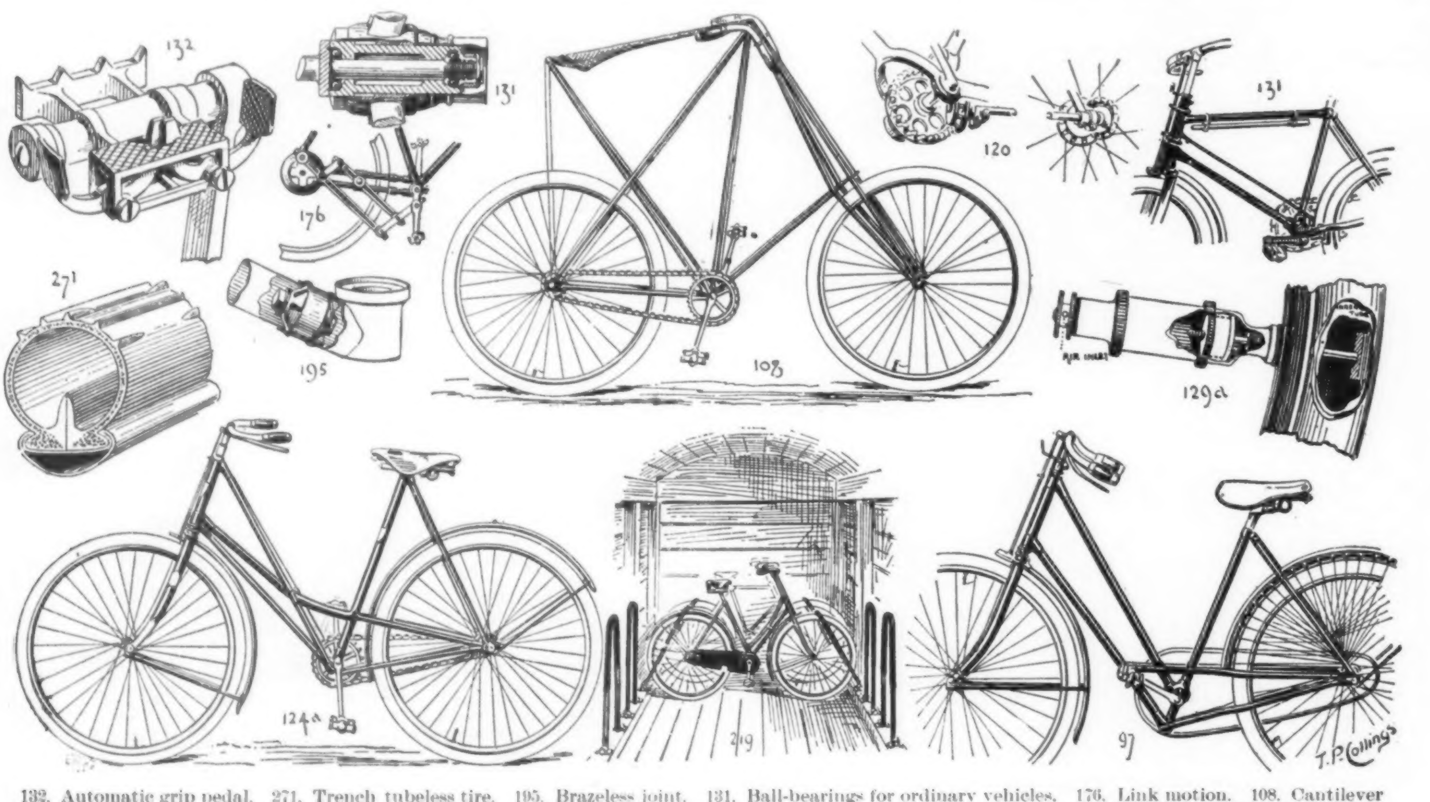
He has endeavored to show that while, probably, rope haulage driven by a steam engine at surface, and also rope haulage driven by a steam engine below, with the steam taken down the pit, are more economical than similar plants driven by either compressed air or electricity, yet that, when the time has arrived for the haulage to be extended, and for subsidiary engines to be put down inby, electricity and compressed air only can be used.

Also that, of the two, electricity, on account of both its greater efficiency and its reduced first cost, is then to be preferred.

For similar and other reasons he has considered that electricity should be adopted for both pumping and coal cutting.

THE STANLEY CYCLE SHOW.

THE twenty-first annual exhibition of cycles organized by the Stanley Club was opened recently at the Royal Agricultural Hall by Sir Albert Rollit, M.P. The show having attained its majority, it was only right that the exhibition this year should be the finest of the series. And it is undoubtedly so. No fewer than three hundred and fifty firms exhibit their goods, and nearly 2,500 cycles are to be seen in the show. Though most of the large Coventry firms reserve their support for the national show which comes a fortnight later, while the Stanley is mainly dependent upon makers from London, Nottingham, Birmingham, Loughborough and America, still this year among the exhibitors at the latter show are to be found the Elswick Cycle Company, Humber & Company, Osmond's Limited, and Rudge, Whitworth & Company. Messrs. Humber & Company exhibit a novelty in the shape of a "Pedersen" safety, constructed on the cantilever principle. For this machine it is claimed that the construction of the frame is so designed that every tube is either in tension or compression, and the strain is accurately proportioned out to those parts most fitted to receive it, with the result that perfect rigidity and strength, coupled with extreme lightness, are obtained. Another novelty in the design of the frame is to be seen on the stand of the Amulet Cycle Company, who exhibit a cycle so designed that without any alteration or addition it is suitable for a lady or gentleman. The firm claims for this cycle that, without adding to its weight, it offers a stronger frame than any at present in use for ladies, and that it gives as much clearance for the dress as does the average lady's machine, while to gentlemen the open front gives convenience in mounting and dismounting. The "Lu-mi-num" Company exhibits an ingeniously contrived pedal, the merit of which is that by the mere pressure of the foot a toe clip is formed, the clip being released directly the pressure is removed. This pedal is so balanced that the clip end is always forward. Another ingenious invention is one exhibited by the Loughborough Cycle and Engineering Company, which is an effort to get over the necessity for pumping up the tires, and consists of a self-acting pump, invented by Messrs. Windsor & Atkins, which is fitted to the rim of the wheel. The action is very simple. If the tire be deflated, that part touching the ground is depressed, and the pump is so fitted that the depression



132. Automatic grip pedal. 271. Trench tubeless tire. 195. Brazeless joint. 131. Ball-bearings for ordinary vehicles. 176. Link motion. 108. Cantilever Humber. 120. Danish application of the Acatène patent. 131. Browning's bi-brake. 129A. Self-acting pump. 97. A new frame. 219. Railway van fitted with cycle stands. 124A. Amulet patent cycle.

SOME NOVELTIES AT THE STANLEY BICYCLE SHOW IN LONDON.

pushes upward the piston of the pump, which comes back again as soon as that portion of the wheel leaves the ground. As the wheel revolves the piston is worked until the tire is fully inflated. The Trench Tubeless Tire Company exhibit their tires, which are practically single tubes. The merit of these tires is that they are easily detachable, and therefore easy to repair when punctured.

More than one firm exhibits a machine in which an effort has been made to supersede the chain gearing. The Acatène Cycle Company's machines are, of course, all chainless, and the firm exhibits a Danish application of their patent. Another chainless cycle is one exhibited by Messrs. Scott and Bonicard Fils, called "La Gazelle." This machine works by means of a link motion describing a double circular movement. One extremity is connected by a cross pin to the right hand crank of the bicycle, while the other extremity turns an internally geared box pinion, which engages the teeth on the driving wheel spindle. The link motion has its fulcrum on the bottom stays of the frame, which are double on the driving side. The gear is made adjustable by changing the pinion on the driving wheel spindle. On the stand of the Engineer Cycle Works is a machine fitted with Browning's "bi-brake." This brake, which can be easily fitted to any machine, is applied mainly to the back wheel, where the sudden application of it does not harm the frame. One advantage of this invention is that, should one of the tires be punctured when a rider is descending a hill, the whole force of the brake is immediately and automatically transferred to the other wheel. Mr. Dan Albone, maker of the Ivel cycles, shows his patent ball-bearing axles and ball-bearing boxes for carriages; and the Brazeless and General Cycle Fittings Company exhibits bicycles put together by its patent system without brazing the joints. The latter patent is a very simple contrivance, and seems to secure perfect solidity. It should be very useful in repairing a damaged frame. There has been much talk lately about the damage done to cycles during their carriage by rail, and railway companies might do worse than adopt the simple method of securing the safety of cycles in transit shown by the Radial Cycle Stand Company, which exhibits a six-foot section of an ordinary luggage van containing cycles secured by a patent folding stand.

We are indebted to The London Graphic for the cut and copy.

WATER TUBE BOILERS.

THE technical maritime associations in France and England had a spirited discussion at their last meeting over the different new types of boilers. As the technical journals have taken up these discussions and extended them, we believe it of interest to give a brief nomenclature of the present models of steam generators (the diversity of which is extreme), in dwelling at a little greater length upon the Niclausse boiler, which recent experiments have particularly brought into prominence.

On shipboard, the question of weight, space and ease of repair and cleaning, with which it is necessary to combine great strength, renders the selection of the evaporating apparatus a matter of great delicacy.

Up to recent years, the ordinary cylindrical boiler, with direct or return flame, satisfied the different exigencies of merchant and naval vessels. Then the necessity of decreasing the weight upon torpedo boats brought locomotive boilers into use, while the slight height between decks of armorclad ships caused the Admiralty boilers to be adopted. These evaporatory apparatus have proved very disappointing, and are now almost universally condemned.

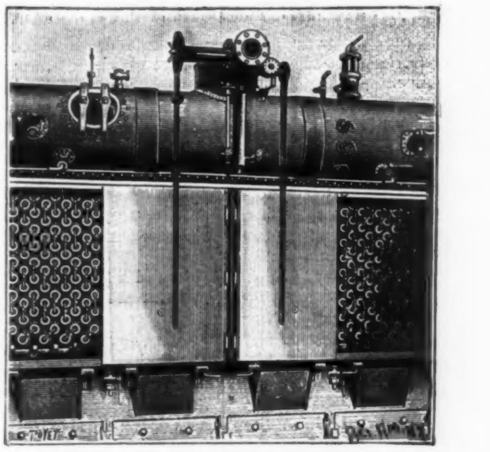


FIG. 1.—NICLAUSSE BOILERS.

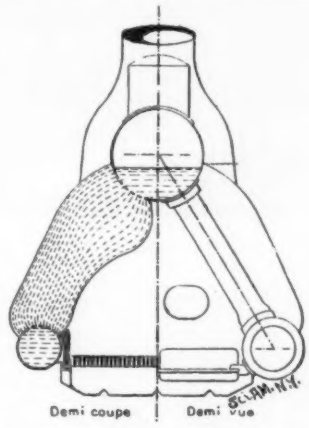


FIG. 2.—SECTION OF THE NORMAND BOILER.

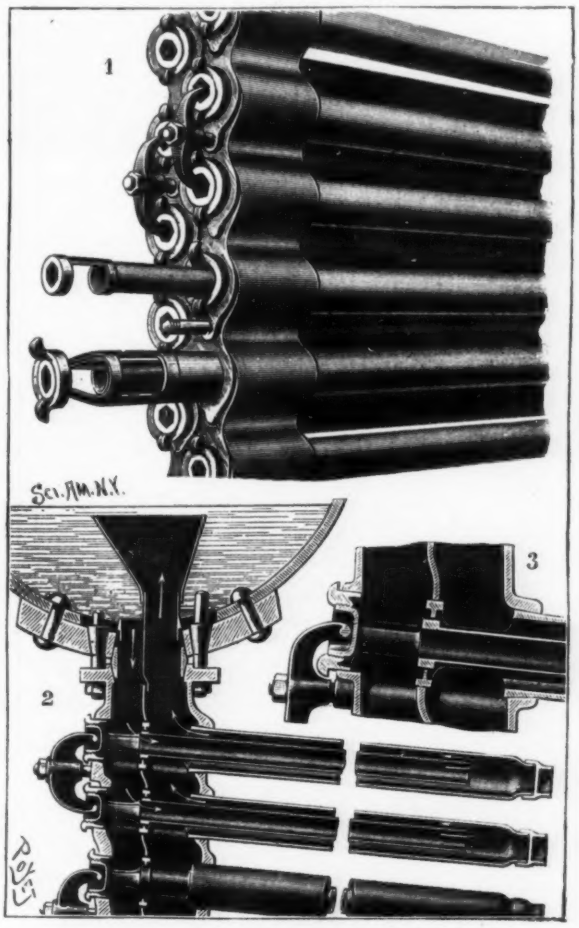


FIG. 3.—TUBES OF THE NICLAUSSE BOILER.

On another hand, the difficulties became greater and greater, and tubular boilers with a large volume of water appeared no longer to answer requirements. Inventors were therefore led to form their apparatus of water and steam tubes so arranged as to be situated in the midst of a flame and hot gases. In order to give a classification of the different types that have been devised, and which are extremely numerous, we shall, like Mr. Bertin, in his "Traité des Chaudières," take as a basis the circulation of water in tubes.

As long ago as 1856, M. Belleville experimented with a model upon the Biche, but it was not till 1884, after thirty years of research, that the Belleville type began to prevail. The water in the tubes of this boiler is almost immovable. The circulation is called "limited." In the French boilers, the Oriolle, D'Allest and De Dion, and the English and American ones, the Babcock & Wilcox, Seaton, Town & Ward, on the contrary, the circulation is "free." The Field, Niclausse and Dürr boilers enter into this category, but must be set apart, since they are distinguished from the preceding by profound differences in construction and operation.

Finally, we shall call the apparatus of Temple and Normand in France, and of Thornycroft, Yarrow, Blechynden, Flemming and Ferguson in England, boilers with "accelerated" circulation. The Belleville boiler consists of a collection of spirals formed of straight tubes and couplings. These are arranged side by side, their lower extremities communicating with a collector, while their upper ones debouch in a reservoir wherein is situated the steam port. The feeding is effected in this upper reservoir in the midst of the steam, and two large vertical tubes allow the water to descend into the lower collector. The level of the water is established in the tubes at about the middle of the height of the spirals. The circulation is almost null, there being merely a replacing of the water evaporated or entrained.

The D'Allest boiler, which we shall take as a type of the first category of boilers with free circulation, is entirely different from the Belleville type. Two parallel water spaces, surmounted by a large cylindrical reservoir which is at right angles with them, are united by a collection of tubes slightly inclined from front to rear. The feeding is done in the back water space. A screen is arranged upon the lower row of tubes, and various obstructions force the flame to traverse a return circuit before reaching the chimney. This arrangement presents serious dangers, since the hotter gases come directly into contact with tubes that may be filled exclusively with steam. The water tends to rise from the rear water space toward the front one in which occurs all the disengagement of steam. This circulation, although called free, is incomplete, and is necessarily interfered with.

In case of the breakage of a tube, this boiler presents great inconveniences, since the taking apart of the tube plates is a long and difficult operation.

In the boilers with accelerated circulation, an upper cylindrical collector and one or more (generally two) lower ones communicate through a bundle of small tubes against which the flame impinges, and through a large tube outside of the boiler. The feeding is done in the upper collector, the water descending into the lower collector through the external tube and rising through the bundle of tubes at the same time that the steam forms. The circulation is thus extremely brisk. The steam port is in the dome that surmounts the upper collector, so as to prevent priming. The different models of boilers of this type are distinguished by the form of the tubes of small diameter and by the level of the water in the upper collector. Sometimes all the small tubes debouch beneath the level of the water, as in the Temple or Yarrow boilers, and sometimes above, as in the Thornycroft apparatus. The grate is situated between the lower collectors, and the current of hot gases, guided by screens, traverses the bundle of tubes before reaching the chimney. In these different apparatus it is impossible to make repairs without a long stoppage and troublesome dismountings (Fig. 2).

In the Niclausse boiler, on the contrary, while the circulation is perfect, the taking apart or repairing can be effected with great rapidity. The weight and the space occupied are greatly reduced, and, finally, the elasticity of this evaporatory apparatus permits of great variation in the operation.

In front of the boiler a series of vertical collectors, divided into two water spaces by an internal partition, communicates at the top with a transverse collector in which the feeding takes place. A bundle of tubes open at the two ends debouches in the front water space. These tubes are inclosed in other tubes of greater diameter closed at one of their extremities by a screw plug and communicating with the rear water space. This boiler thus resembles a Field one with horizontal tubes. The water descends through the front water space into the internal tubes and vaporizes in the external annular part. Then the water and steam ascend through the back water space to the upper collector. Various accessory arrangements, moreover, facilitate the circulation.

The method of mounting the tubes, which leaves the rear extremity free, permits expansion to take place without any inconveniences resulting and assures great elasticity. Finally, it is exceedingly easy to take the apparatus apart. The external tube terminates in a prolongation called a lantern (Fig. 3), which is adjusted to the front and rear water spaces. The internal tube, which also carries a lantern, is screwed to the extremity of the external tube, which it closes upon the partition that separates the two water spaces. A bridge and bolt bearing against the two neighboring heads prevents any unscrewing. As the bearings are conical, it will be easily seen from Fig. 3 that, through special tools, it is very easy to remove the tubes either together or separately.

In conclusion, since we cannot expatiate further upon the carefully studied details of this boiler, we borrow a few figures from a very interesting article by M. Duchesne concerning the recent trials of the "Cristobal Colon," a Spanish cruiser, the boilers of which are of the Niclausse type.

The weight per horse at 14,000 horse power is 44 pounds without water and 53 pounds with. The boilers developed at a natural draught 12 horse power per square foot of grate surface and 10 horse power per square foot of covered surface; and the consumption amounted to about 1½ pounds per horse hour. These remarkable results place the Niclausse apparatus in the front rank of water tube boilers, and, as M. Duchesne concludes, constitute a genuine success for the French industry that has so completely solved the extremely difficult problem of the naval boiler.—La Nature.

LOCOMOTIVE BUILDING IN GERMANY.

HERR VON BORRIES, in a lecture given before the Verein für Eisenbahnkunde, gave an account of improvements in locomotive construction as recently adopted in Europe, and particularly in Germany.

According to Herr von Borries, too little attention has been paid, as a rule, to the destructive effect a running locomotive has upon the track, and the high cost of maintenance of many railways he attributes largely to an improper construction of the engines. The swaying motion of the engines, also the vibrations due to unbalanced rotating parts, greatly add to the static or load strains on which calculations are generally based.

To reduce as much as possible the strain upon the rails, the engines should, in Herr von Borries' opinion, be constructed according to the following rules:

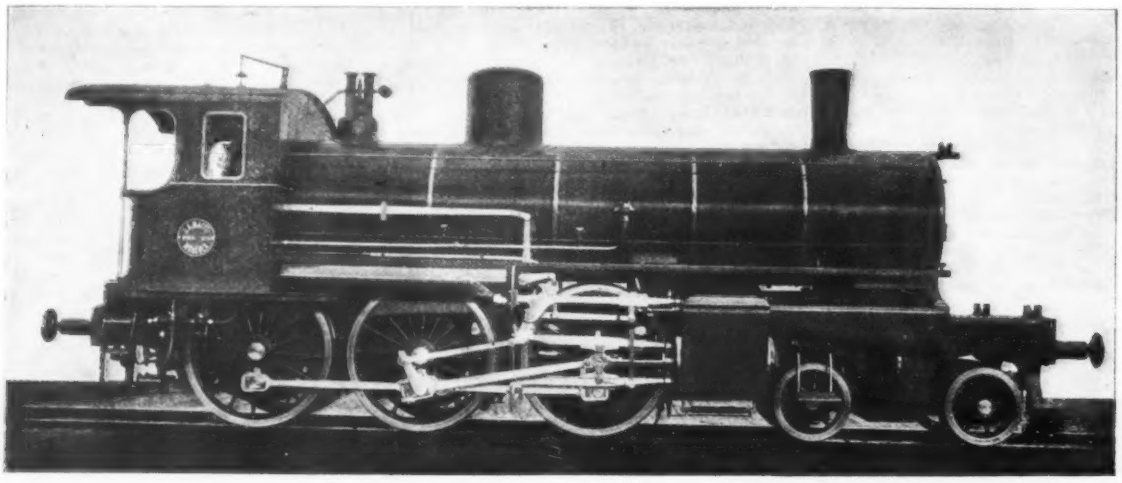
The front axles should carry a moderate load only, and in tender engines, the same rule should be observed for the rear axles. The front wheels, or guiding wheels, should be as far in advance of the main load-carrying wheels as possible. This will give the guiding wheels a considerable leverage, and the lateral pressure upon the rails will be reduced. The front wheels are to be made of moderate diameter and should be supporting wheels only, not driving wheels. The connecting rods should be long, relatively to the piston stroke. A reduction of the distance between the cylinders on the opposite sides of the engine insures a steadier motion of the locomotive. The same object is also attained by properly balancing the moving parts, and by so constructing the axles that the wheels will readily follow curves of the track. Herr von Borries believes that if these rules are followed, the load carried by each axle may be quite materially increased without requiring any heavier rails or stronger track construction than those now used.

The influence of American ideas of locomotive construction is clearly shown in the engine shown in our first cut. This is a four cylinder compound engine, constructed by Maffei, of Munich. The boiler is very long and placed comparatively high, and the front axle is in advance of the boiler. The low pressure cylinders being very large are located exteriorly of the engine frame, and the high pressure cylinders are located within the frame. Maffei, however, prefers to place the high pressure cylinder where our cut shows the low pressure cylinder, and the low pressure cylinders under the smoke box. The high pressure pistons drive the central driving axle, and the low pressure pistons are connected to the front driving axle. Of the ten wheels, six are drivers. The engine, with its full supply of water and fuel, weighs 58·3 tons. The inner and outer cranks are located diametrically opposite each other on each side, so that centrifugal force will act mainly in opposite directions, whereby vibrations are practically avoided. The drivers may, therefore, be rotated at a very high rate of speed without endangering the good condition of the track. The drivers being comparatively small and the pistons very powerful, these locomotives can be used with great advantage on grades of 1 in 100 or more, yet, on favorable track sections, a high speed can be attained. They are, therefore, particularly adapted for use on railways on which grades vary considerably. The front truck is pivoted, and the extreme wheel base is very long, while the fixed wheel base is comparatively short, these features insuring an easy guidance of the engine on curves.

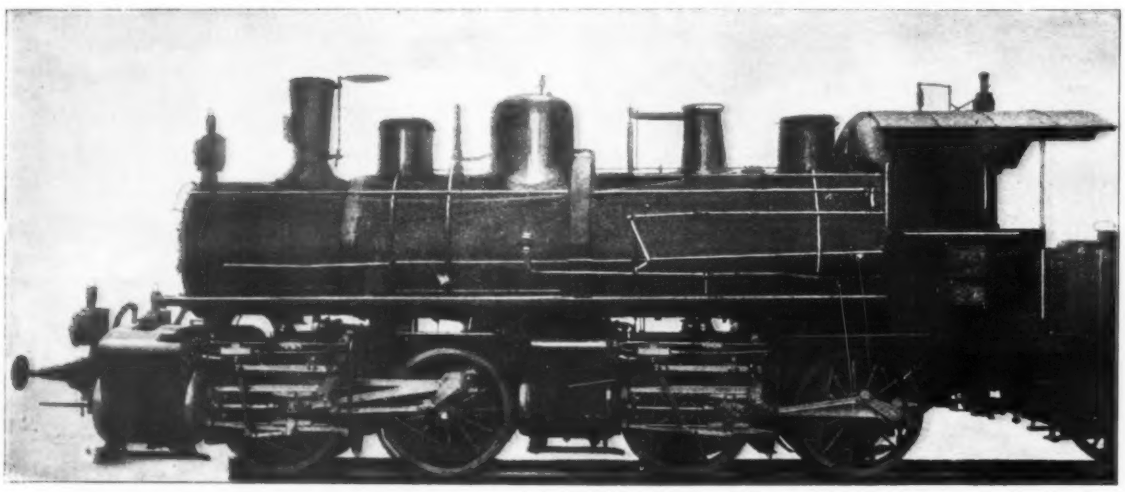
The application of the motive power at four different points and the mutual neutralizing of disturbing influences of centrifugal force, etc., contribute to make the engine very easy running. The drawbacks of this construction are its complication and high cost. Notwithstanding these objections, four cylinder compound express locomotives of the type described are being used exclusively for all new constructions on the Northern, Mediterranean and Western railways of France.

Our second cut shows a Mallet-Rimrott four cylinder engine, constructed by Maffei. There are two trucks of four drivers each, the front truck being pivoted. The cylinders are located in advance of each truck. The distance between the two sets of wheels is rather considerable, thereby increasing the facility with which the engine takes curves. This locomotive must, however, slacken speed on curves, since otherwise the vibrations of the machinery on the front truck put a severe strain upon the rails, since in that position of the truck these vibrations are not absorbed, as it were, by the main body of the engine.

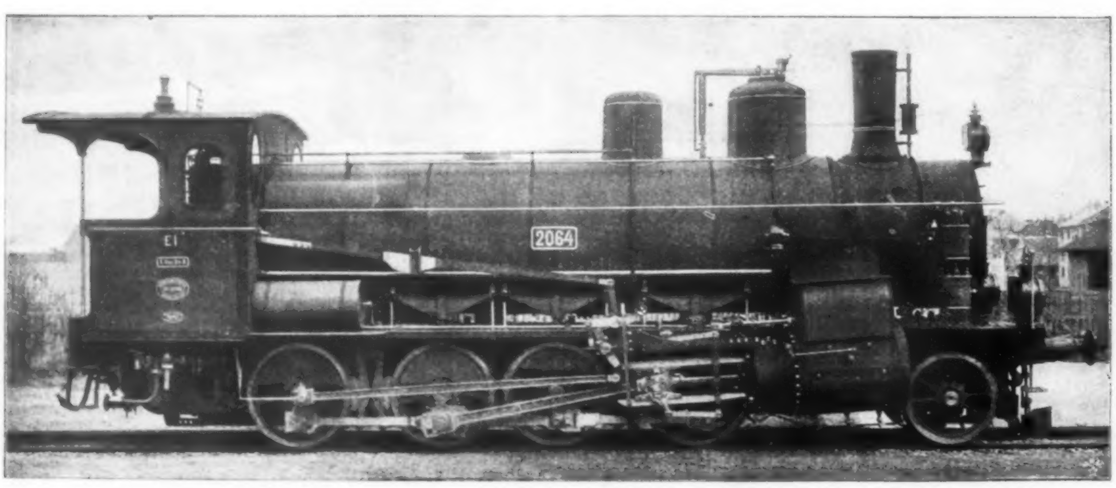
To somewhat remedy this defect, the wheels are made with heavy counterbalancing weights, as shown in the illustration. This, of course, increases the centrifugal force, and to avoid excessive vibration, due to this cause, it is advisable not to run such engines at a



COMPOUND LOCOMOTIVE OF MAFFEI, MUNICH.

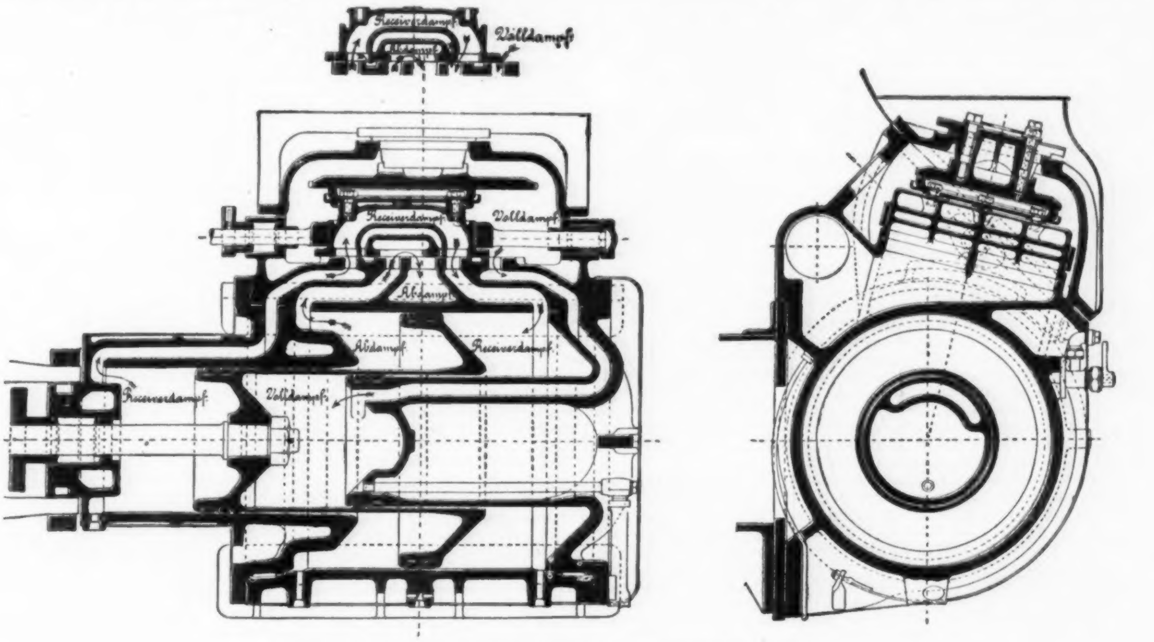


MALLET-RIMROTT ENGINE.



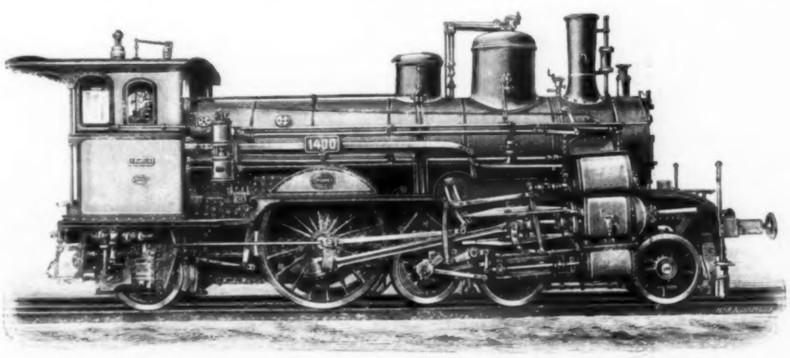
FREIGHT ENGINE OF THE BAVARIAN STATE RAILWAYS.

higher speed than about 180 revolutions per minute. Where five axles (of which four are driving axles) support the locomotive, as in the freight engine of the Bavarian railways (see cut), a higher speed can be readily obtained. This locomotive is remarkable for



HIGH PRESSURE CYLINDER OF FREIGHT ENGINE.

the length of its boiler, also for that of the connecting rods, one set of which extends to the rearmost axle. The diagrams are a longitudinal section and a cross section, illustrating the peculiar steam distributing device employed (Woolf's system). In the position



EXPRESS LOCOMOTIVE.

shown, the piston is driven toward the left by the live steam entering through the longitudinal channel at the upper portion of the cylinder. The steam at the other side of the high pressure piston is expelled into the receiver, as indicated by the arrows, and the exhaust steam from the low pressure cylinder escapes through the central channel. This engine was built by Krauss & Company, of Munich, and proved capable of hauling a train weighing 850 tons up grades of 1 in 130.

Our last cut shows an express locomotive of a very original design, which was likewise constructed at the shops of Krauss & Company. Only one of the axles is a driving axle, which is operated by a compound engine (the two upper cylinders). The driving mechanism thus has very little friction to overcome, so that the engine runs smoothly and at a high rate of efficiency. The load of 14 tons resting on the driving axle might, however, be insufficient to produce a sufficient pull when starting or upon grades. To provide for additional tractive power in such cases, the engine has a supplementary axle (the central axle in the cut) carrying weeels which normally do not rest upon the rails, but may be lowered by means of a steam piston. These wheels form auxiliary drivers, receiving their power from a small duplex engine, whose cylinders are located below the main cylinders. This rather uncommon construction is stated to have been used with success for several months upon the Bavarian state railways. The locomotive is an express engine.

For our cuts and the subject matter of this article we are indebted to Glaser's Annalen.

CLEPSYDRAS.

THE Cluny Museum possesses a very curious earthenware clepsydra, which is to be found in one of the glass cases in the Salle des Faiences. We shall give a description of this, since, although it is reproduced in Pierre Dubois' Histoire de l'Horlogerie (Paris, 1849), and has been figured by us in an article upon clepsydras in a preceding number, its interesting functions have nowhere been described. These we shall be able to make known from a very careful study of them undertaken through the facilities afforded us by M. Saglio, the director of the museum.

This piece dates back to the seventeenth century. Opposite No. 4,021, the catalogue reads:

"Stoneware of Grenzhausen in Westerwalde (Nassau), with the three colors, grayish, blue and violet.—Clepsydra or water clock." It then adds: "The clepsydra was in use upon banquet tables, where it performed the office of an hour glass. The water, placed in the reservoir, descended through the columns and spurted from an orifice below.—Height, 23 inches."

Pierre Dubois says upon this subject:

"It was customary in certain monasteries to place one of these clocks in the center of the table upon which the monks' dinner was served. It was doubtless in order to warn the monks that they must not prolong their meal beyond the limit fixed by the rules of the order."

This clepsydra, in fact, is constructed upon the principle of the hour glass. The hour is indicated by the time that it takes the water to flow from the upper into the lower receptacle. Then, as with the hour glass, it is necessary to turn the piece upside down in order to have it continue to operate. But, although the thing is simple in the hour glass (since the sand flows from one receptacle to the other, the whole being perfectly closed), the same is not the case with this clepsydra, from which the water flows to the exterior.

The following is the ingenious method that was found, not only for preventing the loss of water at the moment of inverting, but also for indicating in a certain measure the fraction of the time of the complete flow from one of the receptacles.

The water was poured in through one of the apertures, AA', formed in each of the flat ends of the receptacles. These apertures were closed with a cork. The water escaped through one of the columns (B, for example), and then continued its way through a tube, C, ending in a nozzle, F, from which it spurted.

It will be seen from the engraving that the water can make its exit from the receptacles only through the aperture in one of the columns, since two of the other columns are solid and the fourth is closed by the tube ending in a nozzle. As for the funnel, its orifice projects above the level of the water.

We have said above that the fraction of the time of flow was indicated. This is how it was done:

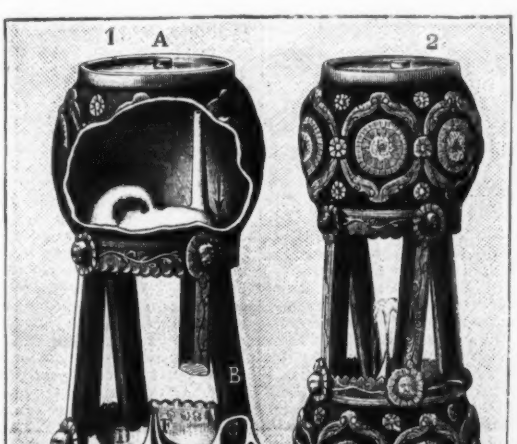
At the beginning of operations, the jet of water immediately reached its maximum elevation, since the pressure was then strong. Then it progressively diminished in height and finally became a mere flow. It was, therefore, possible for an experienced person easily to ascertain the fraction of the time of the entire flow, through the successive heights of the jet.

The water of the jet fell back into one of the two concavities in the internal face of the receptacles. These concavities, in their ornamentation, embraced rose-like figures, one of which, D, was provided with small apertures. The water of the jet entered these orifices, which allowed it to flow naturally and fill the receptacle.

The part, E, forming a funnel, was placed immediately beneath D, and formed part of the bottom. The object of it was to prevent the water from flowing back through the apertures when the piece was inverted, and to permit the air to enter in measure as the water made its exit through the opposite nozzle.

It may be seen how the hour was obtained and how the piece might be turned upside down without any fear of spilling the water.

It was not possible for us to ascertain the time of flow from either of the receptacles, since the nozzles were reconstructed and stopped up at the time the piece



EARTHENWARE CLEPSYDRA OF THE SEVENTEENTH CENTURY.

underwent an important restoration. Then, again, we are ignorant of the thickness of the material forming the partitions, as well as of the proportions of the tubes and funnels in the interior of the receptacles.—"Planchon," in La Nature.

PRESERVATIVES IN FOOD PRODUCTS.

By E. A. S. BAILEY, Ph.D.

DURING the past few years a great advance has been made in the methods for the preservation of food. When we compare our circumstances with those of the people of this country a hundred years ago, we begin to realize how great has been that advancement. While they were dependent for their food supply very largely, at each season of the year, upon the fruits and vegetables of that season, and in every latitude upon the produce of that latitude, and everywhere were dependent upon the local markets for fresh supplies of meat and fish, to-day, on account of the methods of preservation that our industry has proved to be effective, the fruits of one season are at our disposal throughout the year, what is produced in one latitude is a food supply for another, and canned meats and fish are in such common use that we have ceased to regard times and seasons.

The methods employed to bring about this change are very numerous. The inventor has taken into account the fact that a high temperature and exposure to air, especially to moist air, assist in the decomposition of organic matter, and he has sought to eliminate in various ways the causes of decay. If a high temperature is an unfavorable condition, by the construction of cold storage warehouses and refrigerator cars this condition is counteracted. If moist air is objectionable, then the organic material may be dried at a high temperature, and if kept in air that is reasonably free from moisture, it will not decay. If air, laden as it is with the germs that are so prone to find a favorable soil in vegetable or animal food material, can be excluded completely from contact with this material, the problem is solved, and we have the immense canning industry of the present as the outgrowth of that idea. Among the minor methods for preservation of food may be mentioned the pickling in solutions of salt and saltpeter, the preserving in strong solutions of sugar, and the covering with a layer of fat or oil to exclude completely the air.

Notwithstanding all these methods, there has seemed to be a necessity for a more rapid and inexpensive method for the preservation of foods and beverages, and this has led to the use of various chemicals known as "preservatives." This industry has grown up within the last ten or fifteen years, and has begun to attract considerable attention both in this country and abroad. The common preservatives used are sulphurous acid and sodium sulphite, boric acid and boroglyceride, borax, benzoic acid, salicylic acid, saccharin and beta hydronaphthol.

From experiments by Miguel it has been learned that the smallest quantity of boric acid that will prevent putrefaction in neutralized bouillon is 7·5 per cent., and the smallest quantity of salicylic acid is 10 per cent.

That these preservatives are in extensive use is evident from the large number of formulas that are offered for sale, and from items in the "household" department of popular journals recommending the use of "salix" or borax or some other simple substitute as a preservative, in lieu of the laborious work of canning. It has been noticed by manufacturers, also, that the high temperature and prolonged boiling necessary to preserve some kinds of fruits cause them to fall to pieces and injure their appearance; and on this account they have, in some cases, substituted a comparatively low temperature for the prolonged boiling, and have added some of the preservatives noted above to destroy the vegetable ferments.

Probably these methods of preservation were earlier applied to beverages than to canned goods. This is especially true of milk, wine, beer and cider. In their investigations upon foods and beverages, the attention of the United States Department of Agriculture has been directed to the addition of preservatives to food, and they have contributed much valuable material to our knowledge of the subject.

It is a well-known fact that milk is often falsified by the addition of sodium bicarbonate, which of course neutralizes the acid, but rather favors than hinders the growth of bacteria. It gives the milk a peculiar taste. As it enables the dealer to sell sour milk for sweet, it is a fraud upon the public. In addition to this, the continual use of alkaline milk, especially by young and delicate children, who so often depend largely upon it for nourishment, cannot but be detrimental to health.

Salicylic acid is the common preservative in this country for beer and cider. Some experiments were made at the laboratory of the State University with a view to determining how much of this acid was necessary to stop the action of ferments in cider. The sample of cider used was distilled and found to be perfectly fresh and free from alcohol; then several portions of it, of a liter each, were treated with different quantities of salicylic acid, and after ten days, and again after twenty days, examined for alcohol. It was found that one part of salicylic acid in 10,000 was of little value in arresting or preventing fermentation; one part in 4,000 had a decided effect in decreasing the amount of alcohol that otherwise would have been formed; and one part in 2,000 limited the alcoholic fermentation so far that there was less than one-half of one per cent.; and, finally, a proportion of one part in 1,000 practically prevented fermentation. In some published receipts for the preservation of fruits it is recommended to use thirty grains to the quart, or about one part in 500. According to the experiments above noted, this would seem to be excessive.

Most countries have prohibited the use of benzoic acid as a preservative, and the use of saccharin for this purpose has been prohibited in France, Germany and Belgium. In some cases the use of these preservatives for foods or beverages intended for export has been allowed, while it has been prohibited in those intended for home consumption.

An elaborate series of experiments upon the effect of preservatives was made by Leffman and Beam several years ago, and as a conclusion they state that: "Salicylic acid prevents the conversion of starch into sugar under the influence of either diastase or pancreatic extract, but does not very seriously interfere with peptic or pancreatic digestion of albumen. Saccharin holds about the same relation as salicylic acid. Sodium acid sulphite and boric acid are practically without retarding effect. Beta naphthol interferes decidedly with the formation of sugar by diastase, but not with the action of pancreatic extract on starch. Peptic and pancreatic digestion of albuminoids was almost prevented by this agent."

The consensus of opinion of chemists and physiologists, both in this country and abroad, seems to be that, although it may not be wise to prohibit the use of preservatives in foods and beverages, yet from what we know of their action on the system, manufacturers of such substances should be required to state in plain terms that the packages contain such preservatives, and in what proportion they are present; then if the purchaser chooses to use the goods, or if his physician believes they will not injure him, he is at liberty to make use of them. Although in certain cases it has no doubt been proved that persons were injured by the use of preservatives in food, yet the cases are not numerous enough to warrant a wholesale condemnation of the preservatives. The strongest argument that can be presented against the use, and the one in fact that appeals to common sense, is this: Substances that will prevent decomposition and fermentation in the foods themselves will, if taken in the system with the foods, retard the action of the digestive ferments on the food, and consequently must tend to produce indigestion.—Bulletin of Pharmacy.

THE PRODUCTION OF BROMINE.

FOR more than fifty years Pomeroy, O., has been recognized as the principal Southern salt field, rivaling the New York and Michigan fields successfully through the Southern markets. For more than half that time an important by-product has been profitably disposed of, the output increasing in about the ratio the price has diminished. At present the greatest bromine producing center in the United States, if not in the whole world, is in what is termed the Pomeroy bend of the Ohio River.

The first bromine works of any consequence were located at the Stassfurth saline deposits near Magdeburg, Prussia, and about twenty years ago produced about 10,000 pounds yearly—an amount nearly equal to the combined product of the remainder of Europe. As is usually the case, it was a secondary product from the manufacture of potassium salts, the mother liquor containing from 0·3 to 0·5 per cent. bromine in the form of bromide of potassium. In the Pomeroy bend the bromine is obtained from the bittern of the salt works, which at one time was thrown away after the salt had been crystallized out, being considered useless. This contains the bromine as bromides of soda and magnesia. The methods of manufacture by decomposing these salts have changed but little for many years, and are quite similar to those employed at Stassfurth. The expense of the apparatus is not great, and the cost of distilling insignificant. However, the work is quite dangerous to health, on account of irritating properties of free bromine, which are so well known. Every precaution to guard against this is quite necessary, and it is said that those engaged in it must refrain absolutely from the use of alcoholic stimulants.

The usual apparatus for a bromine producing plant is one or more large tanks as containers for the bittern, which is piped from near-by salt works, an intermediate furnace by which the bittern is heated preparatory to entering the stills, and two or more large stone stills or retorts from which the free bromine is distilled.

These retorts are rude-appearing stone chambers, hewn out of native sandstone, and measure about 6 by 8 feet, with a capacity for about 400 gallons of bittern. To this is added about 75 pounds of sulphuric acid to decompose the salts and about 35 pounds of black oxide of manganese as an oxidizing agent, which liberates chlorine from the common salt and other chlorides still remaining in the bittern, which in turn liberates the bromine. The retorts are fitted with cap tops having apertures for the introduction of the acid and the black oxide; from these openings a pipe extends about thirty inches downward into the retort, and is closed by a practically airtight lid. From the retorts a connection is made by a pipe of either lead or earthenware with the condenser, which is usually made of earthenware, over which an abundance of cold spring water is continually passing. Similar connection is made with the receivers, which are glass bottles of sufficient size to accommodate the product of a single distillation. These connections are made tight by being luted with clay. After the retorts are charged and made tight, a current of live steam is passed into them, which causes the reaction to proceed, and the free bromine passes through the condenser to the glass bottles used as receivers, from which it is later transferred to smaller bottles holding from 10 to 20 pounds each.

The average production of bromine at the Pomeroy district is conservatively estimated at 100 pounds daily, for each of some ten plants, or 300,000 pounds per year, which is fifteen times as great as the product of all Europe a few years ago, and more than the total production at the present time.

For a number of years following its first production in the Ohio fields the returns were very pleasing and the profits enormous, the price remaining in the vicinity of \$3 per pound; but as there was simply no limit to the bittern which could be utilized from the twenty-odd furnaces then in operation, overproduction soon resulted in lower and still lower prices, until producers realized but 27 cents per pound, which led some to retire from the business. The abandonment of plants has left but ten salt producers in the field at present, with what is called a "bromine shop" attached to each.—Registered Pharmacist.

The London Times says: "The extension of orchard land in Great Britain, which has been in continuous progress during recent years, has been further emphasized in 1897, the total area now amounting to 224,116 acres, or 15,166 acres more than in 1892, when the aggregate area was 208,950 acres. The three western counties of Devon, Somerset and Hereford alone—pre-eminently our cider counties—contain 78,217 acres of orchards, representing 35 per cent., or more than a third, of the orchard area of Great Britain."

SELECTED FORMULÆ.

Preserving Wire Rope.—What is said to be a remarkably valuable antifriction and preservative compound for mine cables, says The San Francisco Mining Press, is as follows: Seven parts soft tallow and three parts plumbago, mixed thoroughly; make a long, hollow box or trough, gouge out a four by six piece of scantling about two feet long, sawing it down lengthwise and hollowing out the box or trough enough to hold several pounds of the compound, making also a hole lengthwise of the trough for the cable to run through; then affix to rope and clamp securely, having the box or trough so fixed that it cannot play, and letting the cable pass through it while going up or down, so that it will get a thorough coating. This, it is found, will preserve a round cable very well, and can be used at least once a week. For a flat steel cable raw linseed oil can be used instead of the tallow, in about the proportion of six parts oil and three plumbago. If tar is used, linseed oil is to be added to keep the tar from adhering, both ingredients to be mixed while warm.

Etching on Glass.—A citizen of Berlin, M. Retzlaff, is the patentee of a method of etching on glass or porcelain and other glazed surfaces. In the usual German method of etching such materials the surface is provided with a layer of tinfoil affixed by means of a cement. The drawing which is to be etched is then marked on this layer of foil and cut out with a scraper. The parts of foil thus cut out are then removed, and the layer of cement underneath washed off by means of turpentine, thereby leaving bare places on the glass or porcelain surface for etching upon.

The purpose of M. Retzlaff's invention is to substitute for the cutting out of the design, which requires time and skilled workmanship, a chemical process, by means of which the pattern desired can be etched in shorter time, in a more perfect manner, and exactly following the lines of the design. This process consists in transferring the pattern desired to the layer of tinfoil in grease colors, by means of printing or stenciling, etc. The tinfoil leaf is fixed to the glass surface by an adhesive asphalt; the printing of the tinfoil can be undertaken equally well after its adhesion; the so prepared vitreous body is then placed in an acid which dissolves the tinfoil.

The asphalt layer, by means of which the foil was affixed, being now freed, is washed off, thereby allowing the etching on the freed parts of the glass to be proceeded with in the usual manner. The design appears, according to the above described operation, etched in relief on a glass surface. Naturally a sunk etching can be produced in a similar manner. The etchings thus executed are said to be distinguished by special sharpness of outline.—Pottery Gazette.

Invisible Ink.—The following formula is recommended:

Lead acetate	1·0	gramme.
Uranium acetate	0·1	"
Bismuth citrate	1·0	"
Distilled water to	100·0	"

Dissolve and cautiously add ammonia water until the solution is clear. A few drops of sirup or gum arabic solution are then added. It is applied with a quill or a wooden pencil. The writing is invisible, but at once becomes brown-black when exposed to vapors of sulphureted hydrogen, remains legible for a few minutes, then fades to a light brown, but reappears on moistening with highly dilute nitric acid and may be regenerated. As a source of sulphureted hydrogen serve liver of sulphur and vinegar, boiled egg, etc.—Phar. Post.

Crab Apple Perfume.—

(1)	Extract orange blossoms	1,000	
	" violet	1,000	
	" rose	500	
	" jasmine	500	
	" acacia	500	
	Essence vanilla (1 to 500)	100	
	Tincture tolu (1 to 10)	30	
	Essence musk (1 to 50)	15	
	Cumarin	5	
(2)	Tincture ambergris	1	ounce.
	" musk	3	"
	Spirit rose	16	"
	Extract cassie	10	"
	" tuberose	10	"
	" jasmine	10	"
	" violet	16	"
	" rose	32	"
(3)	Oil ylang-ylang	30	drops.
	" mace, liquid	10	"
	" wintergreen	2	"
	" linaloe	20	"
	" coriander	20	"
	" hyacinth geraniol	5	"
	Tincture cassie	2	ounces.
	" violet	4	"
	" musc baur	¼	"
	" styrax	½	drachm.

Mix and filter if necessary. (Griffiths' "Non-Secret Formulas.")

The name "crab apple blossom," as applied to a perfume, is claimed as a trade mark by a manufacturer.—Pharmaceutical Era.

Impervious Floors.—In French hospitals the floors have been painted for hygienic reasons with a solution of paraffin in petroleum, which gives them a brown color and renders them entirely impervious. A single application is said to suffice for two years. Such floors may be wiped daily with a cloth saturated with an antiseptic solution. This device is of great importance to schools, hospitals and private houses.—Süd. Ap. Zeit.

Composition for Hectograph.—The following is recommended: Gelatin, 170 parts; glycerin, 1,410 parts; water, 400 parts. The mixture, after standing some time in the cold, is melted together on a water bath and poured out with care to prevent formation of air bubbles. Addition of salicylic acid increases its keeping qualities. Before using, it is directed to moisten the surface with water and to remove the excess by spreading paper over it. Old writing is easily removed with a sponge moistened with very dilute hydrochloric acid.—Ph. Post.

ENGINEERING NOTES.

At the Duchesse d'Uzès's last hunting party one sportsman followed the chase and was in at the death on a motor phaeton, while another used a petroleum tricycle.

Great difficulty is experienced in the Arlberg tunnel with the products of combustion from the locomotives. The tunnel is 6½ miles long and has no ventilating shafts, the smoke escaping from the east end, which is 288 feet above the western entrance. Some experiments were recently made with the Holden system of oil burning, which proved successful, the smoke disappearing almost entirely. The management of the Austrian state railways has ordered thirty-seven locomotives fitted on the Holden systen, so that coal will no more be used by engines running through the tunnel.

A note concerning the peculiar phenomenon noticed in the melting of metals when under extended pressure has recently been published by H. Bischof, of Wiesbaden. When a metal is bedded in a mortar of chemically pure aluminum oxide, thoroughly dried, and then subjected to the necessary heat, a considerable retardation in melting is noticed. For instance, a rod of silver which should melt at 1,830 degrees Fahrenheit, when thus treated will not change its form and melt together until 5,730 degrees Fahrenheit. Palladium, which should melt at 2,730 degrees Fahrenheit, shows no sign of yielding at 2,900 degrees Fahrenheit. It would seem that these rods of metal, unable to expand while in the powerful grip of the aluminum oxide, which contracts on heating, simply cannot melt as they would under normal conditions. Herr Bischof is engaged in carrying out a series of experiments in this direction with various metals, and future reports will involve a tabulation of the actual moment of melting as shown by special electrical contrivances.

The following table, says The Marine Record, shows the number of ships, barks and barkentines built in the United States for every fiscal year ending June 30, since 1845:

1845	124	1863	97	1881	29
1846	100	1864	112	1882	31
1847	151	1865	109	1883	33
1848	254	1866	96	1884	24
1849	198	1867	95	1885	11
1850	247	1868	80	1886	8
1851	211	1869	91	1887	7
1852	255	1870	73	1888	4
1853	270	1871	40	1889	1
1854	334	1872	15	1890	10
1855	381	1873	28	1891	13
1856	306	1874	71	1892	8
1857	251	1875	114	1893	8
1858	122	1876	76	1894	3
1859	89	1877	71	1895	1
1860	110	1878	81	1896	2
1861	110	1879	37	1897	2
1862	60	1880	23		

At a recent meeting of the Franklin Institute, of Philadelphia, a paper was read by George C. Reese describing a new process of galvanizing wire, by which the wire is coated without the necessity of unwinding the coils. The coils or bundles of wire are first cleansed by acid. The whole bundle is then dipped into the bath of melted spelter, and when it has received a thorough coating it is quickly dropped into the basket of a centrifugal machine. For small or light coils the machine may be already in motion, while for heavier wire it must be started after the wire is put in. The surplus coating is almost instantly thrown off from the wire and an excessive speed is not required. The machine is stopped and the bundle of wire is removed as quickly as possible and is jarred upon a block to prevent the wires from soldering together. Barbed wire has been successfully treated by the new process after it has been twisted into shape and formed into bundles. When wire is galvanized before being barbed and twisted, much of the coating cracks and peels off and the points quickly rust. Treated by the new process, the wire is more durable and retains its efficiency much longer. Wire cloth finer than eight meshes to the inch cannot be galvanized by the old method, while by the new process cloth of any fineness may be coated, if the speed of rotation is increased according to the fineness. Samples were shown of 12 × 13 fly wire 16 mesh, believed to be the first of the kind ever successfully galvanized after weaving.

A new explanation comes from Philadelphia for the fact, long ago noticed by all who have had any experience with burning buildings, that a fire which has long smouldered in one part of a structure will often spread almost instantly to all other parts of it the moment a door or window is opened. The usual theory is that the flames leap into activity because of an increased supply of oxygen, but this hardly accounts for the surprising rapidity with which every floor of a large business block or dwelling is sometimes swept by a fire that has previously confined itself for hours to a single room or part of a room. Experiments recently made by a fire department official in the city mentioned go far toward showing that smoke itself in certain conditions, is both inflammable and explosive. This he demonstrated by means of an apparatus consisting of a deep, round tin can inverted over a smaller can and a gas burner. Smoke was produced by placing hay, grain, wood and other materials in the small can and heating them over the gas burner, the smoke produced being caught in the large can. In the bottom of the latter was placed some excelsior. An opening in the inverted can permitted the air to be driven out, and then the opening was closed. When the can became filled with smoke, the heat of which was not sufficient to ignite the excelsior, a flame placed near the open end caused an explosion and set fire to it. The force of this explosion depends largely upon the material used to produce the smoke, smouldering malt giving the maximum result, and old rags also producing a strong explosion. From this experiment the deduction was that a building filled with smoke is threatened with quick and speedy destruction, and that some means to clear it of the finely divided carbon should be used. Spraying each room with water will accomplish this, a fact that was clearly demonstrated in the course of these experiments.

ELECTRICAL NOTES.

Juggernaut's car cannot pass through the streets of Colombo owing to the interference of overhead telegraph wires. Petitions have been sent to the governor by the Ceylonese, as twenty-five persons wish to throw themselves under the idol's car.

Electrical traction pays in the United States, says Industries and Iron. Ten years ago there was no such thing there; now they possess nearly 14,000 miles of electrically worked lines. One line of thirty miles is stated to have increased its dividends from $60,000, in 1886, to $800,000, in 1896, simply by substituting electric for horse traction.

The directors of the company lighting the Clichy district of Paris have just issued their annual report for the year ending June, 1897, says The Electrician. The length of cable in their distributing network is now 255 miles, as compared with 232 miles last year, the number of consumers having increased from 2,161 to 2,864. The number of 10 candle power lamps per consumer has decreased from 55 to 53. The lamp connection in 10 candle power lamps or their equivalent is 152,846, as against 118,988 last year. Of the former number, 14,622 is represented by motors, 603 by heating apparatus, and 1,150 by public lighting. It is interesting to note that 208 lifts are now at work on the mains, 90 of which are worked entirely by electricity. It is also noteworthy that the use of batteries in the substations, for the purpose of regulation, has been discontinued, compensating machines being used instead. The cells have, in fact, been sold.

Mr. Hiram S. Maxim, in a letter to The London Electrician, furnishes some information in regard to his new lamp, which several months ago was made the subject of a sensational cablegram. After referring to his misquotation by a reporter, he said that he has been attempting to produce a lamp in which a very high resistance might be obtained with a short and thick filament; also to produce a filament which will stand a higher temperature than those ordinarily used, as it is well known that a slight rise in the temperature greatly augments the light given in proportion to the current used. The preparation, however, of the carbon and other materials which form the filament requires a very expensive apparatus, but the cost of the finished filament—excepting first cost of plant—is no greater than with the ordinary lamps. He has tested the new lamps in competition with all the best lamps he could find and states there is no question but what they show a very marked saving in electrical current, and this, of course, is the object aimed at after all. A 42 c.p. lamp gave an economy of considerably less than 2 watts per candle power, and after running two months rose to 52 c. p., but when last tested had dropped to 41 c. p. Mr. Maxim adds that he has not decided as yet whether to keep the process a secret or to patent it.

The total length of life-saving telephone lines is, it is stated, nearly 1,000 miles, and there are more than 200 telephone connections at life saving stations, halfway places, lighthouses and other points in connection with the service covering the Atlantic coast from Maine to Hatteras Inlet, N. C. Linemen's work on the coast is not a pleasant duty, the trips being long, with dangerous inlets to be crossed, and there is but little shelter on the beaches in stormy weather. The one man who has charge of the 160 miles of the North Carolina section has to make most of his trips on muleback. At some points on the coast of Cape Cod the halfway places are connected by telephone with the main line. The designation of "halfway" is applied to a place about midway between two life-saving stations, where the patrols meet and exchange checks during the night watches. The object in connecting the halfway places is to enable the patrols to send in an alarm of wreck or report vessels that may be in distress in the vicinity of the halfway place without having to run back through miles of loose sand, and perhaps in the face of a gale, to notify their station. Many a time when, in the old days, this had to be done, the ship and crew were under the water before help arrived, that now would have been saved. This telephone service is also used in calling tugs to go to vessels in distress at sea, to notify owners and underwriters of disasters, to watch disabled vessels, and in isolated places to call up a physician or substitute patrols in case of sickness, etc. Every section is connected with some telephone office where telegrams can be sent and received.—Electrical Engineer.

The first trial trips on the electric railway up the Gorner Grat, near Zermatt, were carried out recently in the presence of the inspectors of the Swiss railway department, says The Electrician. The section already completed has a length of 1,600 meters and a gradient of 12 per cent. The tests gave complete satisfaction, both the ascent and descent of this gradient being effected without the slightest difficulty, the motors holding the locomotive perfectly to its proper speed. Starting on the maximum gradient with a fully loaded train was also effected with great facility. It will be remembered that this is a rack railway, the total length being 9·8 kilometers, and the maximum gradient 20 per cent. The power is derived from the Findelenbach, which drives four turbines of 250 horse power each, coupled directly to three-phase alternators of 5,000 volts and 40 ∽. Transformers are placed in the power house itself for feeding the line as it passes the building, and two other transformer stations are provided. The pressure on the trolley line is 500 volts. Each locomotive is equipped with two three-phase motors of 90 horse power each, driving the main pinions by spur-gear. Owing to that property of three-phase motors by which they will act as generators and take up the full power which they are designed to give out as motors, when driven at 2 or 3 per cent. above the speed of synchronism, the locomotives will, in descending, give power back to the line. In case only descending trains should be on the line, the surplus power will be taken up in a water resistance in the power house. The contractors for the whole of the electrical equipment are Messrs. Brown, Boveri & Company, who, in the well known Lugano tramway, were the first to apply the three-phase system directly to traction. They have also supplied the electrical parts of the locomotives for the Jungfrau railway, where their system is to be adopted, and are now engaged on the equipment of the line from Stansstaad to Engelberg, which is to be running next spring.

MISCELLANEOUS NOTES.

The year 1897 is the seven hundredth anniversary of the use of coal. In 1197 a blacksmith named Huilloz, of Liege, Belgium, found a black stone which would burn, and which he used as fuel; the stone was, of course, coal, and gradually came into general use. The French name for coal (houille) perpetuates the name of the man who seven hundred years ago introduced the mineral as a fuel.—Revue Scientifique.

Movable carriage wheel guards are made chiefly for use with light carriages that are not equipped with fixed guards. The movable guard is of willow basket-work. In its general outlines it is something like a coat or cloak hanger. It is made to fit over a section of the rim of the wheel. The carriage guard is carried in the carriage, and when required for use, to protect the gown of a woman getting in or out, it is simply held on the wheel.

The International Congress on the Protection of Birds, at Aix-en-Provence, France, last month was arranged by the Ligue Ornithophile Française. The protection of insectivorous birds useful to agriculture was the chief matter discussed, and it was decided to forward to the governments of Europe, through the French Minister of Foreign Affairs, the resolutions which were formulated. Public educational bodies are also to be approached in order to obtain, if possible, the serious consideration of this important subject by schoolmasters and government school inspectors. Numerous French and Italian agricultural, horticultural and sporting societies were represented at the congress, and delegates from the Selborne Society and the Society for the Protection of Birds from England were also present.

Sodium nitrate is now extensively used in the preparation of gunpowders, one of the chief reasons being that, weight for weight, it contains more oxygen than potassium nitrate. According to Merle, the following powders are manufactured with sodium nitrate: Diorrexin contains potassium nitrate, 42·78; sodium nitrate, 23·16; sulphur, 13·4; charcoal, 7·49; sawdust, 10·97; picric acid, 1·65; moisture, 0·55. Amid is a powder containing 38 per cent. of ammonium nitrate; it burns with a small flame, but possesses great force. Saxifragin contains barium nitrate in place of potassium nitrate; its force, however, is but slight. Blasting powders: Himley powder contains potassium chlorate, 45; niter, 35; coal tar, 20; the tar is dissolved in benzine, mixed with the salts, and the benzine then evaporated. Michalewsky powder contains potassium chlorate, 50 per cent.; peroxide of manganese, 5 per cent.; and bran, 45 per cent. Comet powder (American): Potassium chlorate, 15 per cent., and common resin, 25 per cent. Augendre's powder: Potassium chlorate, 49 per cent.; sugar, 23 per cent.; potassium ferrocyanide, 18 per cent. Janite: Niter, 70 per cent.; sulphur, 12 per cent.; bitumen, 18 per cent.; picric acid, 0·4 per cent.; potassium chlorate, 0·4 per cent.; sodium carbonate, 0·3 per cent. Amidogen: Niter, 73 per cent.; sulphur, 10 per cent.; charcoal, 8 per cent.; starch or bran, 8 per cent.; magnesium sulphate, 1 per cent.—Pharm. Centr., xxxviii, 503.

Messrs. Latham, Alexander & Company, of New York, have issued a circular letter embodying the result of their investigation as to the probable cotton crop of the United States for 1897–98. The appended table shows the estimate by States:

	Bales.
Alabama	1,109,000
Arkansas	852,000
Florida	66,000
Georgia	1,430,000
Louisiana	703,000
Mississippi	1,379,000
North Carolina	594,000
South Carolina	875,000
Tennessee, etc	395,000
Texas and Indian Territory	2,785,000
Total	10,188,000

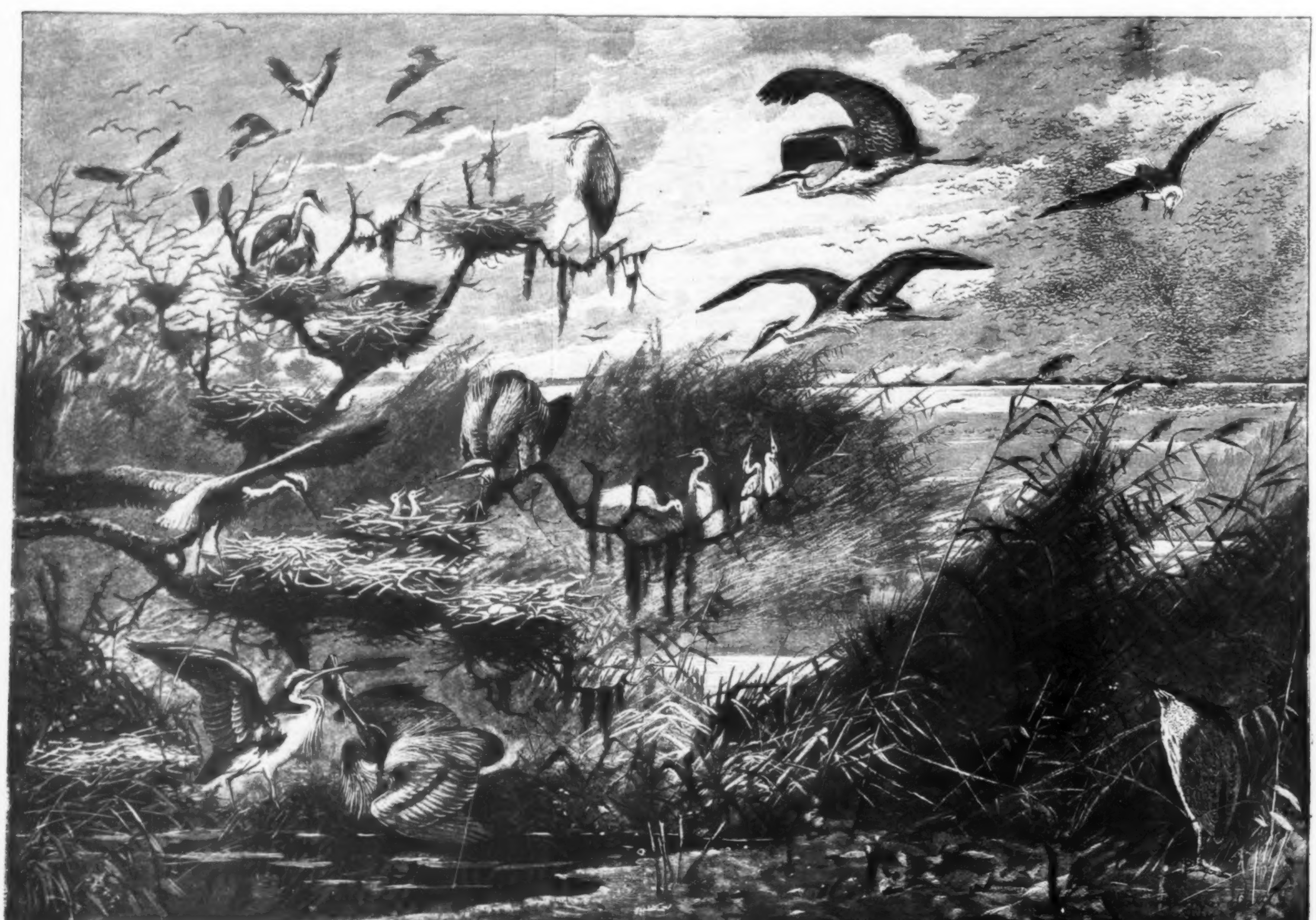
In commenting on the estimate the circular says: "Although the crop was planted late, the drought forced cotton to early maturity, and our correspondents say up to this date the crop has been marketed rapidly. In our opinion, the movement henceforth will not prove to be in excess of the movement of a normal cotton year. For a time quarantine restrictions in a portion of the South retarded shipments, but to a much smaller extent than was generally supposed."

Over 60 per cent. of wood may be converted into liquid, says The Mining and Scientific Press. The strongest hydraulic pressure would not squeeze one-half of one per cent. of moisture from dry wood; but by putting the same material into an iron retort and converting it into charcoal by means of heat, the gases and smoke, to the extent of fully 65 per cent. of the weight of the wood, may be condensed into pyroligneous acid, from which are obtained wood alcohol, acetate of lime and wood tars. A cord of wood weighing 4,000 pounds produces about 2,650 pounds of pyroligneous acid and 700 pounds of charcoal. The pyroligneous acid from one cord of wood produces 9 gallons of 82 per cent. crude wood alcohol, 200 pounds of acetate of lime and about 25 gallons of tar, besides 35 bushels of charcoal. After the pyroligneous acid is neutralized with lime the wood alcohol is distilled off, the lime holding the acetic acid in solution. After the separation of the wood spirit, the remaining liquid is boiled down in pans to a sugar, which is dried, and becomes the acetate of lime in commerce. Acetate of lime is used for making acetic acid. Fully three-fifths of all the wood alcohol and acetate of lime produced in the world are made in the United States. A considerable quantity is also produced in Sweden, and at the exhibition now being held in Stockholm specimens may be seen. Over 15,000 acres of forest per year are cleared in the United States. Wood alcohol affords a perfect substitute for grain alcohol for manufacturing and mechanical purposes, and at less than one-third the cost. It is used principally as a solvent in the making of shellac varnish and in making celluloid and photographic paper. It makes beautiful dye tints, is antiseptic, and is used for liniments and for skin rubbing in bath houses.

A COLONY OF HERONS ON THE LOWER DANUBE.

IN the lowlands of Hungary, before the Danube reaches the Black Sea, it crawls along as if tired from the long course it has run with such force and haste, spreading out innumerable arms and branches that form a 'great swamp, and in the warm season the wilderness of reeds in this swamp teems with life. From a distance one can hear the cry of the quarrelsome eagles, the melodious call of countless snipe and thrushes, the scream of the gull and heron, and with all these are combined the notes of many other swamp birds. Flocks of swans, pelicans and cormorants are busy building their nests, while marsh kites, followed by the pewit, hover over the reeds in search of prey. If we remember that besides all these the swamp harbors an army of frogs and insects, it will be easy to understand that here is a concert which, although it may attract the enthusiastic hunter or naturalist, would drive all less interested persons to distraction.

Such colonies of herons as are found here and there in the swamp along the Danube offer pictures of unusual beauty and interest, for they include thousands and thousands of herons of all the different European species, and while some are busy building their nests, others are resting from this labor, and still others are working incessantly in their efforts to fill the mouths of their half-grown little ones. Unfortunately these colonies are ruthlessly plundered by collectors and so-called hunters, so that they are constantly decreasing in number, and had it not been for the inaccessibility of the swamp, their existence would now be mere matter of tradition.—Illustrirte Zeitung.



A COLONY OF HERONS ON THE LOWER DANUBE.—ORIGINAL DRAWING BY C. V. DOMBROWSKI.

USEFUL INSECT PRODUCTS.

THE commercial value of the insects from which cochineal, lac, and Japanese white wax are obtained were briefly referred to, by Dr. L. O. Howard, in the course of a short paper on a useful American scale insect, read at the last meeting of the Association of Economic Entomologists. It was pointed out that for many years the cochineal or cactus scale insect, now called Coccus cacti, was used as the basis of an important red dye, until practically superseded by the introduction of aniline dyes. In the same way the European Porphyrophora was used in the production of a purple dye. Aside from the dye insects, we have the lac insects, of which a single species, Tachardia lacca, produces practically all of the shell lac, stick lac, and button lac of commerce. This species is Asiatic in its distribution; but in the Southwest States, upon the very abundant creosote bush, a lac insect occurs in an enormous quantity, the commercial possibilities of which have not been developed. This is the congeneric species, Tachardia larreæ (Comstock). This insect has been known to science only since 1881, but was long prior to that time known to the Indians, who for many years have been in the habit of collecting the scale insects and forming them into more or less elastic balls, which their runners were in the habit of kicking before them as they journeyed from one point to another. There are other species of the same genus inhabiting North America. The third substance of commercial importance derived from scale insects is a pure white wax, which is secreted by the Chinese and Japanese Éricerus pé-la and by the Indian Ceroplastes ceriferus. On account of its expense, and on account of more or less available substitutes, this wax has not become of great commercial importance in Europe, but is much used in the Eastern countries, both in the making of wax candles and in medicine. The Chinese wax is said to have ten times the illuminating power of other waxes. It is a beautiful wax, resembling beeswax in its chemical composition more nearly than the vegetable waxes, and is clear white in color. Dr. Howard calls attention to the fact that in the far Southwest of the United States there is a wax insect (Cerococcus quercus) which apparently needs careful investigation from the commercial point of view. Three species of oak are recorded by Professor Comstock as offering food for this insect, viz., Quercus oblongifolia, Q. undulata, variety wrightii, and Q. agrifolia. Dr. Howard recently received specimens of the insect from Mesa Grande, California. They were not sent in position on the twigs, but had been removed from the twigs and compressed together by hand into a more or less pliable lump, somewhat resembling a lump of India rubber, but not possessing the same elasticity. The substance, it is remarked, makes an admirable chewing gum, as it takes and retains flavors better than other gums. Part of it has been proved by chemical analysis to be a true wax, and part resembles rubber in its physical properties. The product is not only interesting from a chemical standpoint, but it may prove to be also of economic value, as the supply is well-nigh inexhaustible. By directing attention to these products of potential importance, Dr. Howard demonstrates the commercial uses of entomology.

THE SAGACITY OF RATS.

SOME years ago, says Public Opinion, as an east coast collier was going up the Thames, a bargeman gave a warning shout, and on looking over the side the sailors saw a rat with its head out of a small hole which it had gnawed in the side of the ship. It was lapping the water like a dog. The collier was beached at once to avoid swamping. It is probable that the bursting of one of these sipping places accounts for the strange stampedes of rats from doomed ships which forms a fixed tradition of the sea. Quite recently an old man died in a Yorkshire seacoast town, who, when a lad in his teens, was the sole survivor from the miseries of a waterlogged ship. For more than two weeks the crew lived on the tops in huts of sails, with no water to drink but the dew they lapped from the masts and yards. As they were unmooring from New York on their fatal voyage, the rats with which the ship swarmed began to troop out in such numbers that they stopped hauling in the cables to let them pass. Stampedes, of course, take place for reasons known only to the rats themselves.

As a Clyde schooner lay moored in a West Indian harbor next to a brig infested with rats, the crew were startled one day by a shout from the captain of the brig, "See what a brood I am sending you!" and, looking over the side, they saw a stream of rats swimming in Indian file from the brig to the schooner. The sailors immediately pulled up all the loose ropes hanging over the sides, and stationed themselves with sticks and belaying pins in the fore and main chains, while two of the apprentices got into the boats and attacked the rats in the water—the rats with wonderful instinct and skill diving to avoid the blows. A curious case of rat engineering occurred some years ago in Brussels, showing great ingenuity and calculation on the part of the rodents, as well as their system of discipline.

A new meat market had been built on Place Street, and though it was surrounded by water, the butchers (who did not appreciate rats) laid their plans to exclude the whole tribe and nation, and in case any should reach their stands they resolved to head off their march by making the posts in their stalls unscalable by rats. This they effected by covering the posts with zinc, and the butchers, looking at the shining surface of the metal, chuckled at their victory. But they reckoned without their host. The rats got the meat. A watchman posted in the market called a butcher, who came early on the scene, to witness the method. On a stall hung two quarters of beef and a leg of mutton. The rats spied them, and found them unapproachable. A general call for the nation at large was evidently sounded, as the rats came flocking in, and an old rat seemed to take command. There were enough projections and inequalities to enable them to reach the table of the stand, but how to scale the zinc-covered joists was the task for the engineer corps to decide. Their plan was soon formed. The rat army moved up in a solid mass, the stout fellow in front. On these climbed smaller and smaller specimens, till a little rat mountain rose. Then some of the rats, who evidently belonged to some rat circus or athletic society, climbed to the summit, and one raised himself on his hind legs, resting his fore legs against the zinc. Then another climbed up his back, and, taking post on his shoulder, assumed the same attitude; rat after rat ascended the Jacob's ladder, till at last one reached the cross beam and scampered along it. A whole regiment followed, and the meat was attacked, the engineers evidently aiming to drop down what they could for the benefit of the army. The lookers-on, however, were not disposed to let them go too far, and with all their engineering skill the rat army had to leave the field. The whole operation showed a remarkable degree of calculation, a system of discipline, and a ready carrying out of plans which seems impossible without language as a means of imparting the directions and wishes of the commander.

PASSIFLORA PRUINOSO, MAST., SP. N.

THIS is a beautiful and distinct passion flower lately discovered by Mr. Im Thurn, and introduced from British Guiana by Messrs. Sander & Co. The leaves are glabrous, palmately three-lobed, subpeltate, green above, glaucous beneath, with the veins of a violet color; the petioles are long, and provided with four to six cup-shaped glands. The stipules are a remarkable feature of the plant, being very large (2 inches long, ¾ inch wide), leafy, cordate, obliquely oblong. The flowers are solitary on long axillary stalks, with three leafy oblong bracts near the top. The flower measures about 3 inches across when fully expanded; the tube short, fleshy, lobed, intruded at the base. Sepals oblong obtuse, aristate, glaucous green externally, pearly within; petals rather shorter than the sepals, pale violet. Faucial corona of very numerous threads, the outermost rows almost as long as the petals; deep violet at the base, in the center yellowish, and curly at the apex; the succeeding rows are about half the length, thread-like, capitate, whitish or yellowish; median corona white, membraneous, at first bent downward, afterward turning upward and dividing into numerous erect threads, each hooked at the base.

The species belongs to the Granadilla section, the section which includes the greatest number of showy species, and among the Granadillas it may be relegated to a small subsection, in which the membraneous or median corona is deflexed, and afterward assurgent. In the size of the stipules it somewhat resembles the figure of P. stipulata, Aublet, but the form of the stipule, and especially of the leaf, is quite different.—Maxwell T. Masters in The Gardeners' Chronicle.

PASSIFLORA PRUINOSA, N. SP.—SEPALS WHITISH, PETALS FLUSHED WITH BLUE. THREADS DEEP BLUE.

Section of the flower to the left—S, sepal; P, petal; R, outer rays of corona.

RECOVERY OF A LOST PLAY OF MENANDER.

FROM the Geneva press there has just been issued a work, says The London Standard, the value of which in the eyes of classical scholarship it is impossible to overestimate. This is nothing less than a considerable portion of a play of Menander, whose works, though he was one of the most highly esteemed writers of ancient times, seemed but a little while ago to have been forever lost to the modern world. Apart from the quotations enshrined, like flies in amber, in the works of other authors, the only well authenticated specimen of Menander's art recovered before this year consisted of a fragment some twenty verses in length, which was brought to light by the illustrious Tischendorf in the course of his Eastern researches. This year, however, M. Jules Nicole brought back from Cairo, among other papyri, six detached fragments belonging to two separate sheets, which, on being deciphered by him, turned out to be part of one of Menander's most celebrated plays, now given to the world under the title of "Le Laboureur de Menandre" (Geneva: Georg et Cie., Librairie de l'Université).

The authorship is placed beyond all possible doubt by the occurrence of three passages which have been quoted by ancient writers and referred to as coming from the play just mentioned. In the words of M. Jules Nicole himself, "We have here nearly a hundred verses so happily setting forth the very thick of the plot as to enable us to reconstitute, not only the list of the dramatis personæ, but also all the best part of the comedy, and to put in their proper place the few other fragments" which belong to this play and which, though previously attributed to Menander, are now for the first time definitely proved to be his work. It is worth recalling that the reason why the most distinguished poet of the new comedy at Athens should be so meagerly represented in our libraries is to be found in the implacable hatred of the Mediæval Church, which proscribed the reading of his works, forbade them to be transcribed and destroyed all the copies on which it could lay its hands.

THE REPAIR OF BOOKS.

FOR refastening a signature that has become loosened by the breaking of the thread, a good needle and strong binder's linen thread are required. A surgeon's needle about two or three inches long and curved at the pointed end is to be preferred to an ordinary sewing or binder's needle. The needle, threaded, should be passed through the incisions made for the threads, into the center of the adjoining sections. Sewing thus back and forth gives the requisite adherence to the section.

Edges of leaves become soiled by much handling, or by accidents, such as being dropped in the mud, or having had some substance spilled over the book while closed. Only where the deflement is restricted to the edges should the following methods be used: If a type writer rubber eraser (the best kind) fails to remove the discoloration, fine grained sandpaper or emery paper may be employed to erase the blemishes. A piece of wood covered on a beveled side with the sandpaper is the most convenient method of filing the edges of the closed book.

Where the dirt extends beyond the edges and yet has left enough of a margin untouched, the binder should be asked to cut off the front portion of the margins without taking the book out of the cover.

A rubber stamp for marking defacements, and lost or stolen leaves or plates, will guard the library against unjust charges of injuries done by the book borrower. It will also be a constant admonition to the vicious and careless reader. Here is a stamp used in the Chicago Public Library:

PAGES......TO .....OF THIS BOOK CUT OUT OR DEFACED PRIOR TO......................

For recoloring worn or rubbed bindings a box of cheap water colors should be purchased.

In cutting a book with a paper knife, hold the knife as nearly parallel to the edge of the book as possible so as to avoid tearing the paper. When through cutting, take fine sandpaper and rub down the cut parts, thus removing the ragged edges.

Many circulating libraries in this country bind the larger portion of their books in black roan and the poorest quality of morocco, generally black in color. The effect of this depressing color upon the library workers who live among the books, and the public who use them, is far from being either æsthetic or cheerful. A well dressed book will receive greater care than one costumed in homely leather and paper. Binding leathers come to-day in a large variety of pleasing shades that are almost as durable as the somber blacks. A library is brightened by the blues, reds, greens and browns of present day tanning. It is a mistake to mistrust the public's right of the public library circulating book. Some libraries use a binder's press for pressing books after they are mended.—J. Ritchie Patterson, in The Quarterly Book Review.

BAFFINLAND EXPLORED.

THAT Baffinland is the third largest island in the world, that it contains vast herds of reindeer, that it is a land of great lakes and also of great rivers, are some of the discoveries made by Dr. Bell, of the Geological Survey, during the last summer, says the Ottawa correspondent of The Boston Transcript. The doctor was a member of the "Diana" expedition, sent to explore the navigability of Hudson Strait, and having performed his part of the work in the strait and Baffinland, he returned to New York from St. John's, N. F., whither the "Diana" carried him on her last call there for coal.

Dr. Bell says the northern shore of Hudson Strait corresponds with the southern coast of Baffinland. What is now found to be one great island, to which this name has been given, was formerly thought to be divided by channels or sounds into several islands. It is by far the largest island in the Dominion, and is only inferior in extent to Australia and Greenland, so that it ranks as the third largest island in the world. It lies northwest and southeast, and is eleven hundred miles in length. Its breadth varies from two hundred to five hundred miles, the average being three hundred. Its southern and eastern sides are high and bold, but there is an extensive plain with a level and rocky surface in the western part of the island, which affords pasturage to vast herds of reindeer or barren-ground caribou.

Although Greenland is covered by a gigantic ice cap, it is generally supposed that no glaciers exist on the opposite or coast side of Baffin's Bay, but Dr. Bell says there are numerous glaciers in the northern part of Baffinland, and that there is also an extensive one in the southern part of the high peninsula called Terre Neuve, between Frobisher Bay and Hudson Strait. In the interior of the southern part of the island, west of Frobisher Bay, small glaciers were seen, and the steep northward slopes of some of the mountains showed many large white spots—the icy remains of great snow drifts which probably never entirely melted away.

Several big lakes exist in the central part of this great island. The largest of these, which is perhaps one hundred and fifty miles long and almost as wide, is called Nettilling. Its northeastern bay is not far inland from the head of Cumberland Sound. To the south of this, and discharging into it by a fine, clear-water river, is the lake Dr. Bell visited from the southward, called Amadjuak, which may be half as large as the other. At the opposite end from that visited the Esquimaus say a glacier discharges small icebergs into the lake, where they float along like those in the sea.

In the same region is a third sheet of water, of considerable extent, called Lake Mingo. The water of all the lakes in this treeless region is absolutely transparent and colorless. Ranges of mountains from one thousand to two thousand feet high and fifty miles in breadth lie between these lakes and Hudson Strait. Another large lake is reported to exist to the northwest of the head of the Frobisher Bay.

Dr. Bell did not see a foot of what could be called good soil in any part of the great island. The whole of Baffinland has a bleak aspect, being rocky and entirely destitute of timber. The northern border of the forests keeps to the south of Hudson Strait. Still the stunted Arctic vegetation gives the valleys and the slopes of the hills in sheltered places a green appearance during the short summer. Grasses and sedges are the tallest plants. Several species of stunted creeping willows grow there, but they cling closely to the earth, scarcely rising an inch above its surface. In the latter part of July the ground in many places is green with a profusion of Arctic flowers of many hues. Salmon abound in the rivers of the eastern coast, and sea fishes are also found around the island. Seals of half a dozen species, walruses, narwhals, polar bears and the smaller whales are abundant in the waters.

Cumberland Sound, where the Dundee whaling stations are situated, is a large bay on the east coast. The principal Esquimau settlements are in this part of the island. It was here that the officers of the "Diana" "raised the flag" and proclaimed British sovereignty over the island. Baffinland may in the future become valuable for fisheries or mines, or from some unforeseen circumstance, and considering its vast size, it may some day prove of importance to the British empire, according to Dr. Bell.

During the time that Dr. Bell was away from the "Diana" he made a track survey, checked by numerous observations for latitude and longitude, of the whole coast and its numerous large islands all the way from near King's Cape to Icy Cove, a distance of nearly three hundred miles. In order to meet the ship again at the place at which he left her, it was necessary to go twice over the same ground, but by steady work, taking advantage of the long daylight in the earlier part of the season, he was able to do this, and was on hand on the day appointed. The "Diana" was also on time, and both he and his crew were glad to get safely away after having finished their dangerous task.

Mr. Luiz A. da Cunha writes thus to The Record and Guide, of New York: "It does not appear to me that you need search for the cause of so many stores being vacant, not on Third Avenue only, but on all avenues, further than the erection of the department stores. I have just been figuring roughly on the area of the largest one. It contains in its seven floors about 540,000 square feet; divide this area into stores of 2,500 square feet, and the result is 216; spread these along Sixth Avenue, eight to the block, and you cover twenty-seven blocks. All this is now under one roof, 184 by 480. Then consider the number of these department stores in various parts of the city, and you can figure out only one result—many vacant stores on all avenues."

MAPS IN RELIEF.

MAPS in relief are of very remote origin, since, without speaking of the topographical plan of the city of Susa mentioned by the eminent M. Maunoir and that dated back to the seventh century before Christ, the first ones concerning which we have exact data belong to the seventeenth century. We might therefore have good reason to be surprised that this branch of cartography, designed by its very nature for popularization, is not better known to the public at large. The reason is simple; it is because the efforts of hypsometrists have always been isolated, and, since they have never

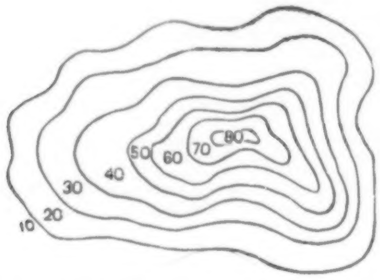


FIG. 1.—CONCENTRIC CURVES OF LEVEL.

left written documents upon their labors, and have rarely found commentators, their productions have almost always remained a dead letter. In the interest of the study of geography, to which relief serves as a natural introduction, there is here a regrettable gap, and we shall be very happy if our appeal succeeds in deciding some qualified scientist to fill it.

The relief map will never supplant the plane one, since the former comes from the latter, and, in the words of Bardin, "the value of the relief depends upon that of the map." Hypsometrical cartography can therefore never have any other pretension than that of playing the part of "precursor." It causes

FIG. 2.—CONNECTED CURVES GIVING THE RELIEF OF A HILL.

geography to be understood and loved, and, again to use the words of Bardin, who cannot be too often quoted in this matter, "its principal merit is due to the fact that it is a powerful means of initiating everybody into a knowledge of the true forms of the relief of the earth, and its evident consequence is to teach how to read topographical maps without difficulty."

What could be more desirable than a "preliminary eye instruction, which first appeals to the imagination, gives the attention a certain degree of force, furnishes reminders to the memory and awakens talent"?

These few lines might, themselves alone, constitute the entire credo of the hypsometric cartographer, and he who proceeds in the path that they point out to him will always be sure of having done useful work if he has been able to imbue himself with their spirit. Unfortunately, it has not always been thus, and we may say that among the number of causes which have retarded the just appreciation of relief maps must be placed in the front rank the commercial ideas that have guided some of the manufacturers. It is, in fact, very easy to begin to construct in relief. Thus, at the Geographical Congress of 1875, we saw some academic exercises in hypsometric cartography which had been executed by pupils of eleven years, and which were most interesting. We can therefore very well understand the attraction that the easy pleasure of parodying their master must have exerted upon some; but when it is desired to produce work that has a real pedagogic value, it is only through a long apprenticeship that it is possible to succeed in obtaining the

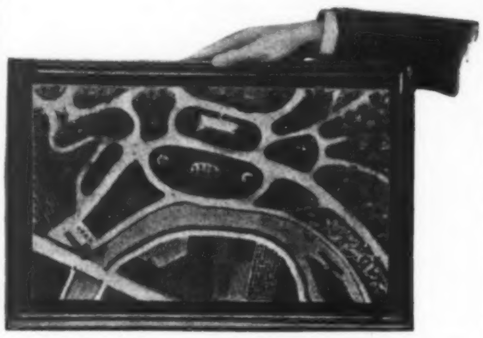


FIG. 4.—RELIEF AT RIGHT ANGLES WITH THE VISUAL RAY

technical knowledge necessary for the judicious selection of a method and to acquire the manual skill indispensable for permitting the finish of the details to render the work comprehensible to every one.

It is necessary in the first place to prepare the beginner for an exact comprehension of what cartography in relief is. To this effect, our venerated master, François Drivet, proceeded to make two very simple but very suggestive experiments, of which, however, he confessed that he was not the inventor. He drew upon a board some concentric curves of level representing as nearly as possible a hill known to the pupils (Fig. 1). Then every curve was cut out, and thus became independent and fitted accurately into the lower one. These curves were connected by means of narrow strips of linen, in giving them the play of an equidistance. This done, there was adapted to the top curve a small handle, which was so placed that upon drawing it vertically the curves separated and gave the relief of the hill approximately (Fig. 2).

On another occasion he exhibited to his pupils a plan in relief, and, having made them place the eye on a level with the lowest elevation (Fig. 3), told them to suppose themselves to be two or three hundred times smaller (in a word, to reduce themselves to the scale of the plan), and then asked them to take a walk in the landscape represented in the latter. The object of this first part of the experiment was to give them an accurate idea of the reduction of elevations. Afterward, taking the same plan, he placed it at quite a distance and at right angles with their visual ray (Fig. 4), thus making them understand, without any other explanation, what a vertical projection is.

This little object lesson was scarcely anything more than a diversion, but it sufficed to awaken the curiosity of the neophytes and to excite in them a desire to know more about the subject of hypsometric maps.

Extended visits were then made to all the museums in which collections of reliefs were to be found; to the National Library, where one can go over a series of such works, from the relief plan of Bellevue (dated 1777) and the remarkable productions of Pierre Lartigue (about 1800) and the work of Karl Schroeder (1865), to the Marine Museum, where were formerly to be seen reproductions of our five military ports (dated 1829–1835); to the School of Mines; to the Geographical Society, the library of which possesses quite a large number of such maps; and, finally, to the Museum of the Invalides, where is to be found a large collection of most remarkable reliefs, but which unfortunately is accessible to the public during only one month in the year.

It was not until after these preparatory visits that the pupils passed to the study of construction properly so called.

In the hope of interesting those who are occupied with cartography, we shall, in our turn, give a description of some of the processes that have been taught us.

The most widespread process of construction consists in superposing pieces of cardboard exactly calibered to the equidistance chosen. But to this effect, it is necessary in the first place to establish a base that shall be as exact as possible. Such base consists of a board perfectly plane, if the relief is to be constructed on a large scale, or respecting the curve of the earth, if the scale is less or if the ground to be represented is of wide dimensions. In this line, we have seen a study relative to the construction of France in relief to a scale of $\frac{1}{100000}$, the accuracy of which left nothing to be desired. These boards are formed of small rectangles set one into another and counteracting so as to prevent a play of the wood. After the establishment of the base, the operator cuts out the pieces in accurately following the form of the curves of level precisely drawn, one by one, upon the cardboard. Then he superposes the pieces by means of register marks made to this effect (Fig. 5). Care is taken to establish at the sides a

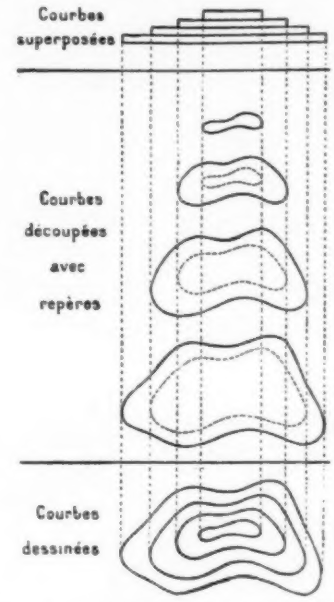


FIG. 5.—CURVES CUT OUT, WITH REGISTER LINES.

couple of squares fixed to the board in such a way that the pieces of cardboard shall rise in a line absolutely straight and at right angles with the base.

It is in the course of this operation that it is well to verify constantly the altitudes and figured dimensions in order to obtain an exact relief. Several instruments have been invented for this purpose. The following is a description of one of these, the principle of which is the same in all the others: The cartographic hypsometer, as it is called, consists (1) of two straight edges, A, with racks; (2) of a horizontal slide, B, which moves up and down the straight edges through the intermedium of small toothed wheels that engage with the racks, and which is provided at each extremity, at D, with a small spirit level; and (3) of a vertical slide, C, which travels over B from left to right and also upward

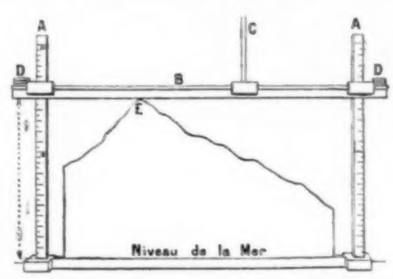


FIG. 6.—USE OF THE HYPSOMETER (HILL).

and downward. The straight edges and the vertical slide are graduated in demi-millimeters.

If it is a question of obtaining the altitude of the summit, E (Fig. 6), it will suffice to bring the horizontal slide to this point, when the reading of the height will be done upon the straight edges. If, on the contrary, it is the altitude of the valley, F (Fig. 7), that it is desired to determine, it will be necessary, after bringing the horizontal slide upon a summit, G, in proximity, to cause the vertical slide to descend to the point, F. The height sought will be obtained by subtracting the measurement, a b, read upon the slide, from the measurement, e d, read upon the straight edge. The altitude of F will be expressed in demi-millimeters by c e. A simple reduction to the scale of the map will give the true height.

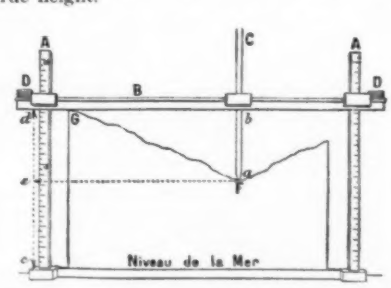


FIG. 7.—USE OF THE HYPSOMETER (VALLEY).

With a graduated horizontal slide, it is possible also to read the lengths upon the relief.

This method of superposing the pieces of cardboard is one of the oldest, since it was Commandant Chepy who, in 1850, was the first to make use of it at the Depot of War. It is the one, moreover, that it is well to popularize, since it is within reach of everybody. But there exist improved processes. Certain cartographers make use of a machine that cuts the curves

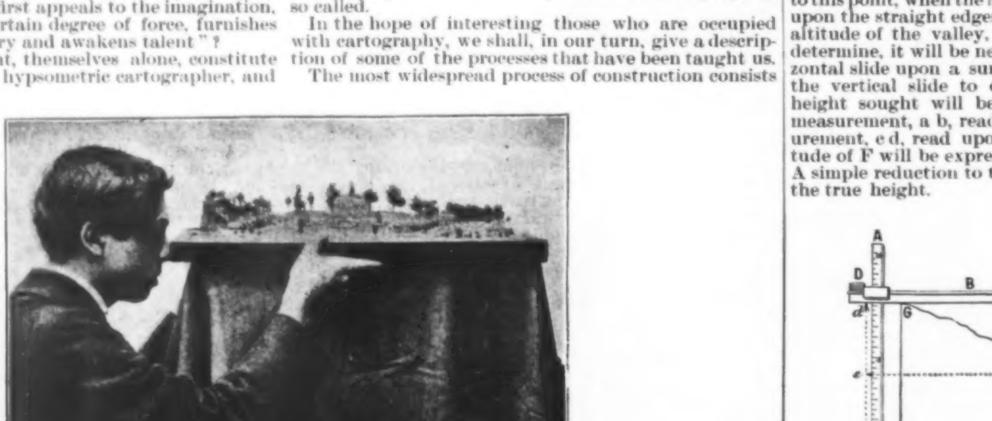


FIG. 3.—PLAN IN RELIEF.

from a block of plaster. This apparatus, which is a combination of a drilling machine and the dentists' foot lathe, has for its working part a sort of chisel that revolves several thousand times a second. The operator causes this chisel to move in all directions until he has obtained a plane surface having the form of the first curve of level. Then he maneuvers a device that lowers the chisel by one-half, one-quarter or one-tenth of a millimeter, according to the equidistance chosen. He then begins on a second curve, and so on until the work is completely finished.

In both cases, a relief in steps is obtained. It is these steps that it is necessary to cause to disappear in order to obtain the real model of the region that it is desired to represent. Certain hypsometrists fill them with a sort of paste, which subsequently soldifies, while others, after reproducing their first sketch by moulding, sculpture the relief in trimming off the prominent angles. This latter process permits of digging deeper into the material and of giving a much more artistic finish; but the sculptor must have a sure hand and possess a thorough understanding of the general forms of terrestrial relief.

There are also the processes of construction by profiles, points and boring. In the first, one establishes several profiles, which are vertical sections of the relief to be represented. These profiles are fixed perpendicularly upon the base and the interstices are filled with some modeling material or other. In the two other processes, one obtains, either by rods marking the elevation or by boring at the desired height, the principal altitudes indicated upon the map, and then, with the aid of the latter, the hypsometrist sculptures his material.

But in these various cases the part left to interpretation is so great that such processes can hardly be recommended for establishing exact reliefs.

The original thus established is, therefore, in its three dimensions, the image of the ground that it is desired to reproduce; but, in order to render it more "speaking," it is necessary to complete it by sculpturing, and by a coloring that recalls the tints of nature. Here, again, processes vary to infinity. Some persons paint the relief in oil colors and draw the planimetry upon the color. Others content themselves with a drawing accompanied with a few touches of water color. Finally, others bring out every detail very exactly by sculpturing. Certain maps are finished with inalterable coloring of remarkable thinness that permits of giving tones that in softness resemble those of aquarelle. Upon a ground shaded with tints in which we find the entire scale of greens, yellows, and the various earths, the roads appear in white, the water in bright blue, the houses in red, and the forests in dark green shaded with brown, and all this intersected by the black lines of the railways.

There exist also plans in relief constructed according to what is called the transfer process. This consists in adapting a map printed upon special paper to a sculptured relief by the aid of register marks. This mode of construction, although not so accurate as the preceding, gives very appreciable results from a practical point of view, since it permits of manufacturing reliefs cheaply.

Upon the whole, we may say that, under whatever form it may be produced, the relief has in its favor the clearness of the three dimensions. Well made and well finished, it is the exact reproduction of nature itself, as one may see by examining, for example, one of the numerous relief plans of Mont Blanc—that colossus of which the majestic proportions have tempted more than one hypsometrist from Séné to Bauerkeller, and from Bardin to Drivet.—A. Blanc, in Revue Encyclopédique.

VOICE PRODUCTION.*

By WILLIAM NICHOLL, A.R.A.M.

I CAN only hope, in the time at my disposal, to touch on a few of the many branches which belong to voice production; and it shall be my endeavor to treat the subject in such a manner as will prove of interest to the speaker as well as to the singer.

My experience, as a student, singer and teacher, convinces me that the real art of voice production is yet in its infancy. The knowledge which enables a teacher accurately to diagnose all voices coming under his instruction is indeed rare, and it must remain so till those who teach have had practical experience, not only in the production of their pupils' voices, but in the production of their own voice. The violinist does not profess to teach the pianoforte or the pianist the violin. These, and many other branches of music, are taught by those who have made a special study of the subject. Nearly every one, whether violinist, pianist, organist, or conductor, undertakes to teach the art of voice production. I would like it to be fully understood that, in my remarks on this subject, I am not advocating anyone's particular method.

Personally, I have a strong objection to the word method, as applied to voice production, when it, as is frequently the case, implies that an individual possesses some secret of producing good tone which is his own particular discovery, and must, therefore, be as carefully guarded as if it had been patented. Voice production is no secret. It is the result of a natural use of natural means in a natural way. Voice production on the part of the teacher demands first a knowledge of how to produce good tone, and secondly, a knowledge of how to obtain the desired quality of tone. Every instrument must possess at least three essentials in the production of tone—(1) motive power, (2) tone producing agent, and (3) the reinforcers of the intrinsic tone.

The violin, which I shall take as an example because it is more familiar to the majority than other instruments, possesses these three essentials in (1) the bow, (2) the strings, and (3) the violin itself. The bow we will liken to our breath, the strings to our vocal cords, and the violin to the resonators of our voice. Now the great difference between the violin and the voice is that in the violin we have the fixed resonators only, in the voice movable, in addition to fixed, resonators.

No doubt you have noticed that we can produce a variety of tones with the violin. The first efforts of the uninitiated are far from pleasant, even if made on the finest "Strad" in the world. Why should it be so? Because the player is producing, from lack of knowledge and practice, a bad intrinsic tone. The violin as a resonator is reinforcing the tone created by the vibration of the string or strings by faulty bowing. As the bowing improves the tone improves, we therefore find one thing only necessary to master in tone production on the violin, because the resonators are fixtures.

The intrinsic tone of the voice is produced by the vibration of the vocal cords. The size and shape of the resonators determine, to some extent, the quality of the voice. The quality is more materially affected by the adjustable resonators.

Our first object in playing the violin is to master bowing; our first object in voice production is to master breathing. Manuel Garcia told me correct breathing formed 75 per cent. of the whole work of a singer.

Of the various methods of breathing, abdominal and costal are the best known. In abdominal breathing we have a decided increase in the region of the abdominal cavity, slight lateral expansion, no movement of the shoulders, and little or no expansion of the upper walls of the chest.

In emission of breath for tone we have the tendency to a downward pressure, especially toward the end of the breath; so much so in some cases that the voice suddenly collapses. This is not the result of shortness of breath, but of wrong application, and if we reverse the action, we find that we are enabled to produce a bright tone without taking a fresh breath. This alone is a strong factor in favor of costal breathing.

In costal breathing we have a flattening of the abdomen, great lateral expansion of the ribs and an increase of the whole thoracic cavity, from collar bone to diaphragm.

It has been demonstrated that apart from greater control we have greater capacity; I cannot, therefore, imagine why there should still be any doubt on the subject, except from the fact that we are all more or less loath to give up old habits. Another immense advantage in costal breathing is that, through obtaining a greater quantity of air and greater compression, the tone is more strongly reinforced. It is almost needless to say that I advocate costal breathing, for both singers and speakers, and my reasons for so doing are based on the best of all reasons—practical work. I used abdominal breathing for the first eight years of my career, but when I adopted costal I obtained increased strength of all the abdominal muscles, greater capacity and control of breath, and in the voice, increased brightness.

Respiration consists of two acts, inspiration and expiration. The amount of breath we inspire is determined by the expansion of the thoracic walls.

Breath should be inspired through the nose, and never through the mouth. Dr. Greville MacDonald gives the following results, in a treatise on "The Respiratory Functions of the Nose," showing how the temperature is changed from the time it enters the nostrils until it passes through the pharynx just above the larynx. When inspired at 20° F. the temperature rose to 82°; at 40° F., it rose to 95°; at 53° F., to 96°. When inspired at 112° F., the temperature was reduced to 92°.

The temperature of the blood is 98·4°. Before the air reaches the vocal cords it must have virtually attained this heat. Cases of obstruction in the nose, and consequent deterioration of quality of voice, are common, and in the majority of cases, due to faulty respiration. Many teachers are of opinion that breathing through the nose can only be indulged in when the voice is not being used. This is quite wrong, and either goes to prove the teacher's defective power of breathing freely through the nose, or his unbelief in the ability of others to carry out what he is incapable of carrying out himself.

Before leaving the subject of inspiration, I must say a word on the subject of corsets. It will be short and to the point. No woman who wears them can breathe properly. The lateral expansion I have mentioned in costal breathing is a closed book to those who do. If women would only realize that in the "abdominal muscles" they have the finest corset ever made, which only require to be developed by exercise, they would never wear them again. Some of you who have seen native women in the East can vouch for their splendid figures. They have never known any dress which has destroyed the figure. I believe the present popularity among the fair sex of bicycling is doing more to bring about a healthy form of dress than all the doctor's warnings or teacher's lectures on the subject.

From inspiration I am naturally led to say something about expiration, and again I must remark that practical experience, both as a singer and teacher, are my sole reasons for advocating the use of certain methods.

With the object of arriving at a solution to the problem of breath control, Dr. Wyllie, in 1866, made numerous experiments upon the exsected larynx, by which he demonstrated that "there is within the larynx a double valve which is capable of controlling both the exit and entrance of the air." Drs. Cash and Lauder Brunton confirmed the experiments made by Dr. Wyllie, and recorded in an article on "The Valvular Action of the Larynx." I will quote from this article:

"Our own investigations completely confirm those of Dr. Wyllie. If the view that the function of the false cords or ventricular bands is to close the glottis during effort, and thus fix the thorax, is correct, we should expect them to be strongly developed in those animals whose habits render fixation likely to be serviceable; on the other hand, we should expect them to be absent in those animals in which fixation of the thorax would be of little or no service; and this seems to be actually the case."

The above points to the fact that all animals who have the power to lift, strike, or hug have the false cords fully developed, because, in order to get lifting power, force to strike, or to hug, the breath must be held in check; the thorax then forms the point d'appui, or point of resistance. Those animals who have no such power have no false cords.

It is conceded by throat specialists that the false cords do close when a breath is held in check; but so far, with a very few exceptions, they have been unable to say it these cords can be governed so as to control breath. It must be remembered, however, that throat specialists make their observations under conditions which preclude the possibility of a pure tone being produced.

What further proof have we, apart from the observations of the medical men I have quoted, to show that the false cords will govern breath; and why should we want to prove they should? For the first step, in establishing this all important principle, I will take that which appeals to the majority of teachers and singers, viz., the exercise which is known as the "shock of the glottis." I prefer to call it attack, as the word shock is apt to give the idea of force. The famous opera singer, Maurel, in his lecture, delivered some years ago at the Lyceum Theater, laid great stress on the attack (coup de glotte) as an important factor in voice production. Let us analyze this attack.

"When the expiratory muscles are used as in expiration, and at the same time the escape of breath is prevented by the closure of the false vocal cords, the air in the lungs becomes compressed. . . . When these cords are opened slowly, an unmusical sound is produced, and when they are opened suddenly a sharp, resonant, explosive sound is produced." In releasing the air the sound of the letter "u," as in the word "utter," is heard. "The little explosion accompanying the sound of escaping breath we shall call the attack (usually called 'shock') of the glottis. The force of the escaping breath which follows the attack should be varied by altering the aperture between the false cords until the student gains full control over them. . . . We not only obtain breath control by this exercise, but we also learn to produce a perfect intrinsic tone, i. e., a tone produced by the unimpeded vibrations of the vocal cords, a tone which is free, pure, rich and sonorous." In the breathy falsetto voice the false vocal cords are nearly as wide open as in expiration, and the vibration of the vocal cords is confined to the thin edge. Here we have one force at work (the breath), and we find it an impossibility at first to change this voice into full voice without a break. This break would be called a change of register by those who believe in registers. The possibility of converting the breathy falsetto tone into pure voice without a break can only be achieved by the development of the false cords, and the ability to gradually close them from the full open position until the vocal cords begin to vibrate in an air of equal density."* Did we not possess false vocal cords, we should, as Dr. George Cathcart said at the meeting of the Incorporated Society of Musicians at Scarborough, a few years ago, "not only cough like a cow, but sing like a donkey."

I have mentioned the word "registers." That there are frequently breaks in a voice we must all concede, but that these breaks arise from natural causes or belong to such a perfect instrument as the human voice I utterly disbelieve. Teaching on the system of registers is the cause of much mischief. I am glad to see from correspondence and articles in some of our leading musical magazines that not only are the false cords as a breath controlling medium taking a healthy hold in teachers' minds, but that registers are slowly but surely being ignored in voice culture. It is quite enough to have to deal with faults which we find in a pupil, without adding a host of complications. When a singer has studied sufficiently to have good command of his voice, there should be no undue effort of mind or body. The work should be as freely and as easily accomplished as the ordinary speaking voice. In such a case not only will the singer feel absolute freedom and ease, but the listener will be spared the pain of having to witness facial contortions, and the many other means the badly taught artist employs in order to get his notes out. The compass of the voice will expand both up and down, and three to three and a half octaves will not be looked on as phenomenal, as it is now.

Taylor, in his "Sound and Music," says that "when a sounding body causes another body to emit sound, we have an instance of a remarkable phenomenon, called resonance."

"The second body, in such a case, is called the sympathetic resonator. There are two kinds of such resonators of the voice, fixed and adjustable. To the first belong all the fixed bones situated above the abdominal cavity; to the second, the walls of the chest, the trachea, larynx, tongue, lower jaw, soft palate, lips, cheeks and nostrils."* A perfect management of the voice depends on the knowledge of how to use the resonators. It is immaterial to the singer which he possesses, and, to quote the late Sir Morell Mackenzie, in his "Hygiene of the Vocal Organs," the difference between artistic and inartistic production of the voice depends far more on the management of the resonators than on the adjustment of the vocal cords.

So far we have treated of breathing and the balance of breath and tone. Many artists can produce good tones in their vocal exercises which suffer considerably the moment they attempt to apply language to these tones. I shall, therefore, say something on the subject of balance of language and tone. It is the second great branch of a vocalist's work, and what applies to vocalists equally applies to speakers.

Melville Bell says the voice organs and the articulating organs are entirely separate and independent; that "the quality of clear cut articulation depends on the due separation of the functions of the vocalizing and articulating organs. The vocal sound seems to be unbroken because the actions of the tongue and lips, while interwoven with it, do not interfere with it. All singers and all speakers may attain this bright excellence of articulation by forming consonants with the economic impulses of the pharynx instead of the wasteful explosion of breath from the chest. The element of audibility in oratory, as in singing, is the voice, but the voice carries with it to the remotest corners of church, hall, or theater, the articulations of the mouth, which of themselves would be inaudible over such an area. Let the fact be noted that this beautiful result when most perfectly attained does not involve laborious effort, but, on the contrary, is accomplished with a minimum of labor and fatigue on the part of speaker and singer."

Now I will give you a few examples of what we hear when the conditions are not such as Melville Bell avers they ought to be. We hear the first line of our national anthem rendered "God save our gracious (s) queen." The chorus in the Messiah sing "For (r) unto us a child is born." In a very beautiful song, by the late Goring Thomas, we get "Time, gentle-handed driver,

* A paper read before the Society of Arts, London, from the Journal of the Society.

* From "A Text-book on the Natural Use of the Voice," by George Thorp and W. Nicholl.

his (s) piteous (s) team compels." And the tenor tells us he "calls life's (s) crew together," in Dibdin's immortal "Tom Bowling." Study Melville Bell, and you will find that it is possible to get rid of these difficulties to the great benefit of both language and tone.

Our linguistic faults are, as a rule, traceable to imitation at infancy. A boy who shows musical aptitude, if he takes up the piano or violin, commences his studies at the age of five to seven years. When he is 17 he has, if properly trained, mastered all the difficulties and avoided bad habits. The poor voice, however, has been allowed to go its own sweet way, and has year by year increased its load of faults, so that at 17 or 18 we have to deal with an instrument which has been wrongly used, and, in some cases, so badly treated that it is almost impossible to cure the disease. In such cases it is the rule to condemn the instrument, which might have turned out, if properly looked after, a priceless one. You may possess a "Strad," but it is easy to produce bad tones if you are ignorant as to how it should be played. In such a case we blame the player. In the majority of cases of bad voices we blame the voice. We ought to blame the user of the voice.

I would draw your attention to the table of consonants and vowels, and I will go over them and give their true articulation. The three voice consonants, B, D and G, I use as exercises for development of the mouth, pharynx and trachea. B develops all three, D the two last, and G the last only.

In the breath consonants notice how the consonant, if produced by a puff of breath from the lungs, destroys the vowel, and how, if produced with the air in the mouth, is strong without injuring tone. Try and sing "show" with a clear tone on the "oh," separate "sh" from "ow," and you will see what I mean — "show" — giving "sh" its articulation and "ow" its tone. Now join the two, and see if you still preserve the tone you got on "ow" alone; if you do, you have solved the problem of good articulation in breath consonants.

Now I contend that such work as this ought to be taught in our schools. Do you know a boy or girl who can articulate a consonant if you asked them? I do not. I find that they do not even understand what you mean by articulation. As for adults, if they understand you, it is a matter of time and patience to attain any degree of facility, simply because the organs employed have got stiff and rusty from want of use.

Flexibility of lips is rare among untrained voices and flexibility of the tip of the tongue still more so. We work with our throats and the base and root of our tongues.

Why should there be such a difference in tone quality when such conditions are present? Sound, like light and heat, travels in straight lines. It is commonly (in the case of the voice) supposed to roll out of the mouth. Well, it does not. We begin, we shall say, with one line of sound starting at the vocal cords. The condition of the throat above the vocal cords determines how few or how many lines and angles the sound takes before it leaves the lips. The two diagrams on the board will illustrate what I mean. In one you have a case in which the tone strikes soft substance many times before it comes to a bright resonator, therefore the whole tone would be a woolly one; the second gives a more equal balance of bright and soft resonators, and the tone therefore would be full, round and sonorous. I will illustrate the action of the resonators with a tuning fork, first resonated on this book, secondly on the piano, and thirdly on the book placed on the piano. The first is a muffled tone, the second inclined to be hard, and the third has the combination of both, and gives a good round tone.

You will notice that the closer I make the contact of the book to the piano, the better the tone; in fact, we seem to hear a "crescendo," and without any more effort, so far as the intrinsic tone is concerned. So in our voice, the admixture of hard and soft resonators, under ordinary conditions, gives a round, agreeable tone.

Before I conclude I think it will interest you to hear something about the phonograph and the lessons it teaches us. I made experiments on both singing and speaking voice on one of Edison's phonographs for two years. At first, I was under the impression that loud tones could not be recorded with satisfaction as to the result heard when the record was repeated; but I found that bad results were only due to force. If anything approaching a pure tone was made, however loud, a good record was the result. This applied to both the singing and speaking voice. In looking at the cylinder (which takes 100 lines of record in its circumference to the inch) it was very easy to tell if any word or tone had been forced. The particular part of the line with a forced word or tone always showed a broader scratch than the other fine indentation which the needle had made. It was always a fine example of "how little we hear our voices as others hear them," to listen to the remarks made by the individual who made a record and then listened. The singer jeered at the idea of that being a bit like his voice; although when he heard someone else make a record and then listened, he was amazed at the truthfulness of the instrument. The reciter not only failed to recognize his own voice, but did not believe that he dropped his voice at the end of sentences as the phonograph did. We most of us know how an untouched photograph not only tells the truth, but seems to exaggerate it. The phonograph seems to exaggerate to a still greater degree, but I think this is only due to the concentration which listening to its records necessitates. If we cultivate that much neglected "concentration," we find we hear many things we were unable to detect. How few take the trouble to cultivate it.

There are fully 12,000 hides tanned weekly in Newark, N. J. About half of these become shoe tipping and vamp leather, the remainder carriage, dash, furniture and fancy leather. More horse hides are tanned than in any other place in this country. Cordovan vamps are the product. Chrome tanned sole for bicycle shoes is made and the manufacture of kangaroo and kangaroo kid is an important interest. All kinds of bag and book leather are produced. The tanners are said to get more money out of a hide than anywhere else. Three and sometimes four splits are made and finished. It is estimated that $16 is realized per hide and the yearly business done amounts to $10,000,000.

THE
Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
361 Broadway, New York, N. Y.

TABLE OF CONTENTS.

	PAGE
I. ACOUSTICS.—Voice Production.—By WILLIAM NICHOLL	18355
II. ARCHÆOLOGY.—Recovery of a Lost Play of Menander	18353
III. BOTANY AND HORTICULTURE.—Passiflora Pruinoso.—1 illustration	18353
IV. CARTOGRAPHY.—Maps in Relief.—A very important article giving detailed instructions for making relief maps.—7 illustrations	18354
V. CHEMISTRY.—The Production of Bromine	18350
VI. CYCLING.—Stanley Cycle Show.—This article describes some of the novelties of the year in the English cycling world.—13 illustrations	18346
VII. ELECTRICITY.—Engines and Dynamos for the Bradford Electric Light Station.—A description of the Willans engine coupled direct to Siemens dynamos.—1 illustration	18343
VIII. HOROLOGY.—Clepsydras.—1 illustration	18349
IX. HYGIENE.—Preservatives in Food Products.—By E. A. S. BAILEY	18350
X. LOCOMOTIVE ENGINEERING.—Locomotive Building in Germany.—An important article, dealing with some of the most advanced types of construction in Germany.—Illustrated by cuts made from photographs and detail drawings.—6 illustrations	18348
XI. MECHANICAL ENGINEERING.—The Comparative Advantages and Disadvantages of Steam, Compressed Air and Electricity for Power Purposes in Coal Working, with Special Reference to Coal Cutting and Haulage.—By G. E. MCMURTRIE.—The Iron and Coal Trades Review prize essay.—A valuable article giving important data	18345
Plaster Casts and Other Methods of Moulding Shell Forms.—By JOHN C. KNOEPPEL	18344
XII. MISCELLANEOUS.—The Repair of Books	18353
Selected Formulæ	18350
Engineering Notes	18351
Electrical Notes	18351
Miscellaneous Notes	18351
XIII. NATURAL HISTORY.—A Colony of Herons on the Lower Danube.—1 illustration	18352
The Sagacity of Rats	18352
Useful Insect Products	18352
XIV. STEAM ENGINEERING.—Water Tube Boilers.—Description of several French types of boilers.—4 illustrations	18347
XV. TECHNOLOGY.—Wire.—This article gives valuable information regarding wire, which is not readily obtainable elsewhere	18343
XVI. TRAVEL AND EXPLORATION.—Baffinland Explored	18353